BANGALORE METRO CORPORATION LIMITED

Driving Bangalore Ahead

BANGALORE METRO RAIL PROJECT PHASE-II TENDER DOCUMENT FOR

Re-routing of existing 66kV 630sqmm Copper EHV UG cable from 66/11kV NGEF KPTCL Sub-Station to 66/33kV BMRCL RSS at Baiyappanahalli depot of BMRCL under Phase-II Project.

TENDER NO. BMRCL/2023-24/EL/WORK_INDENT17

VOLUME-1 (Part B - UG CABLES)

TECHNICAL SPECIFICATIONS

March-2024

III Floor, BMTC Complex
K.H. Road, Shanthinagar
Bangalore-560 027

VOLUME – 1 (Part- B)

i. TECHNICAL SPECIFICATION OF KPTCL ADOPTED BY BMRCL (UG CABLE)

Re-routing of existing 66kV 630sqmm Copper EHV UG cable from 66/11kV NGEF KPTCL Sub-Station to 66/33kV BMRCL RSS at Byappanahalli depot of BMRCL Phase-I Project.

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TECHNICAL SPECIFICATION FOR THE SUPPLY AND ERECTION OF 66 KV, 630 sqmm XLPE INSULATED UNDERGROUND CABLE AND ACCESSORIES

1.00.00 **SCOPE** :

1.01.00 This specification provides for the establishment of an underground cable transmission scheme on total turnkey basis which include the design, manufacture, inspection and testing before dispatch, packing and delivery F.O.R. (destination) of **66kV 630Sqmm Single Core XLPE** insulated lead sheathed UG cable and accessories under the supply portion and laying including obtaining permission for road cutting from Bangalore Mahanagara Palike (BBMP), Local Administrative Authorities and other agencies for execution of work, handling and installation of materials required in laying, site testing and commissioning under the erection portion.

1.01.01 **SITE** :

The site is located in Bangalore City, Karnataka State, India.

Route: Please refer the enclosed drawings for the tentative route plan of the cable.

1.02.00 **SCOPE OF WORKS**:

The scope of work includes;

1.02.01 Surveying of the proposed cable routes including digging and closing of trial pits, preparation of requisite drawings and finalizing the cable route in consultation with the owner's representative.

NOTE: In the expected cable route, ground structure may dramatically change from one point to another, and in some places like Railway Crossing , Major Road Crossing, the local environment is especially bad which may lead to unexpected accelerated aging of insulation and would limit the life expectancy of the cable itself. The successful bidder has to executive works by taking all the necessary precautions so as to get **600 Amps** of current flow in the cable.

Even after considering the entire derating factor for laying cable in those locations, the continuous current shall be **600 Amps**.

1.02.02 Testing and evaluation of the soil resistivity, soil thermal resistivity, PH value of the soil along the cable route and based on the data, recommend the final system design.

a) Perform a through route soil thermal resistivity survey by in-site testing along the entire cable route.

b) Conduct a detailed analysis of soils/strata encountered along the route for the thermal performance under specified cable loading.

c) Specify a suitable thermal backfill that the soil T.R. does not exceed 120^0C cm/watt, to encapsulate the cables to prevent thermal run away of cable.

d) Design of optimum cable trench and optimum backfill dimension.

e) Formulation of thermal backfill, quality control and supervision during backfill.

f) Obtaining Road cutting permission from BBMP, Local Administrative Authorities and any other permission from other utilities.

1.02.03 Design the method of installing U.G. Cables, cable laying, excavation and back-filling of cable trench, supply and installation of associated materials like sand, bricks, warning tape, protective slabs, pipes, ducts, civil works, etc.,

1.02.04 Design, manufacturing, testing at works/test house, supply, storage, installation, testing and commissioning of 66KV cables with all associated materials and accessories.

1.02.05 Design, Supply, Erection, Testing and commissioning of

a) Surge voltage limiters

b) Grounding switches.

c) Link boxes for earthing with links and with/without SVL.

1.02.06 Design, supply of materials and construction of cable ducts, supports for cable crossings, storm water/sewerage drains wherever required. Design, supply of materials and laying of pipes / construction of cable ducts for Road Crossing & Railway Crossing wherever required.

1.02.07 Supply, installation, testing and commissioning of

a) Normal straight through joints.

b) Outdoor cable terminations.

1.02.08 Design, supply and erection of structure for mounting/ supporting cable with terminations.

1.02.09 Supply of recommended essential spare parts.

1.02.10 Supply of tools and tackles.

1.02.11 Furnishing all relevant drawings, data and instruction manuals.

1.02.12 Supply of consumable items like cable end sealing caps for cable during Transport and jointing and all others associated sundry materials.

1.03.00 **SCOPE OF SERVICES:**

1.03.01 The Scope of the services includes supply, installation, laying erection and commissioning of the cable system on total turnkey basis. The scope shall include but not limited to the following.

1.03.02 Complete checking, monitoring, storing of the materials at the site and co-ordination of work. Transporting of materials from site stores to site and returning unused material to BMRCL stores.

1.03.03 Finalize procedure of installation and erection in consultation with owner.

1.03.04 Regular supervision and following up of erection/ installation work.

1.03.05 Testing and commissioning the system/equipments for successful commercial operation.

1.04.00 The cables and its accessories shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer/erection and the owner shall have the power to reject any work or material which in owner's judgment is not in full accordance therewith.

1.05.00 All the volumes of this bid documents along with amendments thereof be read and interpreted together. However, in case of a contradiction between the "Technical Specification (Vol. I Part B)" and any other volume, the provisions of this volume will prevail.

1.05.01 It is not intent to specify completely all the details of Design and construction of cable and accessories. However, the cable and accessories shall conform in all respects to the high standard of engineering design and workmanship and shall be capable of performing continuous commercial operation up to the suppliers guarantee period in a manner acceptable to the Owner who will interpret the meanings of drawings and specifications and shall have power to reject any work or material, which in Owner judgment, is not in accordance therewith. The cable offered shall be complete with all the components necessary for its effective and trouble free operation. Such components shall be deemed to be within the scope of the bidder irrespective of whether they are specifically brought out in this specification and/or in the commercial document or not.

NOTE:

1. The scope shall cover supply of all required equipments, accessories, spares and jointing kits and tools and plant, competent supervision and consumables. All other matching materials required (whether specifically mentioned or not) for complete installation, testing and commissioning of the system shall also be covered.
2. After completion of laying and back filling the road shall be restored as per specification of BBMP authorities. Specification of the same is enclosed as Annexure-A of this part.

1.06.00 **QUANTITIES**: The quantities; length of cable, number of accessories and other materials indicated in the bid proposals are solely for the purposes of bid

evaluation. The contractor after the detail route survey shall estimate the actual quantities and take up manufacture and procurement action for material after approval of the owner.

2.00.00 **STANDARDS :**

2.01.00 The construction of the cable shall generally conform to IS 7098 (part – 3) and IEC 60840 with exception to the specific requirements of these specifications and tests as per IEC – 60840 4th edition 2011. Except of the extent mentioned in the specification, the cables and the accessories shall conform to the latest editions and amendments of the standards listed hereunder wherever applicable.

IEC-60050	Electro Technical vocabulary.
IEC-60060	High voltage test techniques.
IEC-60093	Recommended tests for volume and resistivity of electrical insulating materials.
IEEE-48	Test procedures and requirement for AC cable terminations 2.5 to 765 KV
IEEE-404	Cable joints for use with extruded cable rated 5to138KV
IEC-60122	Recommended method for determining the comparative tracking index of solid insulating materials under moist condition.
IEC-60183	Guide to selection of high voltage cables.
IEC-60216	Guide for the determination of thermal endurance properties of electrical insulating materials.
IEC-60228	Conductors of insulated cables.
IEC –60228 A	(First supplement) Guide to the dimensional limits of the circular conductor.
IEC-60229	Test on cable over sheaths which have a special protective function and are applied by extrusion.
IEC-60230	Impulse test on cables and their accessories
IEC-60243	Recommended method of tests for electrical strength of solid insulating materials.
IEC-60250	Recommended method for determination of permittivity, dielectric dissipation factor of electrical insulation materials at power audio frequencies.
IEC-60270	Partial Discharge Measurements

IEC-60287	Calculation of continuous current rating of cables, 100% load factor.
IEC-60502	(Applicable clauses only) Extruded solid dielectric insulated power cables for rated voltages from 1KV up to 30KV.
IEC-60540	Test methods for insulation and sheaths of electric cables and cores.
IEC-60811	Common test methods for insulating and sheathing materials of electric cables. (Applicable parts/sections of different editions)
IEC-60840	Power cable with extruded insulation for voltages above 30 KV (Um – 36 KV) up to 150KV (Um-170 KV) – Test methods & requirements.
IEC-60853	Calculation of the cyclic and emergency current rating of the cable.
IEC-60885-2	Electrical test methods for electric cables. Part: 2 partial discharges test.
IEC-60949	Calculation of thermally permissible short circuit currents, taking into account non-adiabatic heating effects.
IEC-60885-3	Electrical test methods for electric cables. Part-3 Test methods for partial discharge measurement on lengths of extruded power cables.
IS – 1885	Electro Technical vocabulary applicable parts.
IS-5831	PVC insulation and sheath of electric cables.
IS-7098 (part-3) -93	Cross linked polyethylene insulated, thermoplastic sheathed cables 66KV to 220KV
IS-8130	Conductors for insulated cables and flexible cords.
IS-10810	Method of test for cables: Applicable parts.
IS-3043	Code of practice for earthing
IS-1255	Code of practice for laying of power cables.
IS-5216	Guide for safety procedures and practices in Electrical works
	Indian Electricity Act - 2003
	Indian Electricity Rules 1956 or its latest amendments

NOTE : For the purpose of this specification all technical terms used hereinafter shall have the meaning as per IEC/IS specifications,

2.02.00 The standards mentioned above are available from:

Standard	**Name & Address**

IS Bureau of Indian standards, Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi – 110001 INDIA

IEC International Electro Technical commission, Bureau central De la commission, Electro Technique Internationale 3, Rue De Verembe, P. O. Box 131 CH-1211, Geneva 20, Switzerland.

2.03.00 Cables/cable accessories satisfying the quality requirements of other National /International standards, which ensure equal and better quality than the standards mentioned above shall also be acceptable. Where the Equipment offered by the supplier conforms to other Standards, salient points of difference between the standards preferred and the specified standards shall be clearly be bought out in the offer. Four (4) copies of the reference standards in English language shall be furnished along with the offer.

3.00.00 SYSTEM DATA:

i. 66kV, 630 sqmm, Single Core XLPE insulated lead sheathed cable.

a) Rated voltage:

The cable defined in this specification have the following rated voltage:

U_o/U (U_m) = 38/66 (72.5) kV

"U_o" is the r.m.s. rated voltage at power frequency, between the conductor and the earth or the metallic sheath:

U_o = 38 kV

U is the r.m.s. rated voltage at Power frequency, between two phase conductors:

U = 66 kV

"U_m" is the maximum r.m.s. voltage at Power frequency, between two conductors for which the cable and its accessories are to be designed:

U_m = 72.5 kV

b) Operating conditions:

1. Normal rated voltage (Kv rms)	-	66
2. Highest system voltage (Kv rms)	-	72.5
3. Number of phases	-	3
4. System frequency (Hz)	-	50 ± 3%
5. Impulse withstand voltage 1.2/50 micro seconds wave of positive / negative polarity (Kvp)	-	325
6. Power frequency withstand voltage (Kvrms)	-	90
7. System earthing	-	Effectively Earthed (Solidly grounded)

8. Maximum fault level duration	- 40 KA for 1 sec
9. Dynamic withstand capacity	- 78.75 KA.
10. Short time rating of 66 KV	- 40 KA circuit breaker
11. Total Relay & Breaker operating	- 120-150 time (Milliseconds)

4.00.00 **i. 66kV, 630sqmm, Single Core XLPE insulated lead sheathed cable.**

A. CLIMATIC CONDITIONS:

SITE LOCATION : At various locations in Bangalore city (INDIA) Nearest port – Chennai (Madras).

1. Ambient air temperature	-	Min 5 deg. C
	-	Max 50 deg. C
2. Ground temperature at a depth of	-	30 deg. C 1500 mm
3. Altitude above Mean Sea Level (M)	-	1000
4. Average Rainfall (mm)/annum	-	1000
5. Keraunic level(days/year)	-	40-50
6. Seismic level (Horizontal acceleration)	-	0.3g

B. OPERATING CONDITIONS:

I. CABLES :

1. Method of installation	-	Directly buried in ground
2. No. of circuit	-	Single/Double
3. Depth of laying	-	1500 mm from the center to trefoil arrangement.
4. Soil condition	-	Dry Heterogeneous garden soil
5. Thermal resistivity of soil. (Assumed) Deg C-cm/watt	-	120-150

Bidder shall furnish the Current Rating of 630Sq.mm Cable at thermal resistivity of soil at 120°C- cm/ Watt and 150°C – cm/watt. However the successful bidder has to measure the Soil thermal resistivity along the cable route and the cable has to be designed suitably.

6. Formation	-	Trefoil Touching
7. Spacing between two circuit (if applicable)	-	600 mm (for 2 circuits)
8. Sheath Bonding	-	Single point Bonding/Both End Bonding / Cross Bonding

Bidder shall recommend the type of bonding to be adopted with detailed calculation of sheath voltage, sheath current and current rating.

9. No. of cores	–	Single
10. Conductor size	–	630 Sq.mm
11. Rated continuous current		

i. In Air		–	800 Amps
ii In ground		–	600 Amps (after considering all derating factors)
12. Conductor material		–	Annealed Copper

III. TERMINATIONS :

1) Installation		-	Outdoor type / GIS Module plug in type in conformance with IEC 60854.
2) Atmosphere		-	Polluted
3) Switchgear		-	SF6 Circuit breaker (AIS/GIS)
4) Clearance (air)	ph-ph	-	2000 mm
at 66 KV (Phase voltage)	ph-earth	-	1800 mm

5.00.00 TECHNICAL PARAMETERS OF CABLE:

i. 66kV, 630sqmm, Single Core XLPE insulated lead sheathed cable.

TYPE OF CABLE : 38/66 KV Single core, 630 sq.mm , stranded, annealed, copper conductor, segmental compacted, circular – circular, XLPE insulated, lead sheath, copper wire screen, High Density Polyethylene outer sheathed cable .(Please see details under construction of cable).

The tests shall be as per IEC-60840	-	with latest amendments
Voltage grade.	-	38/66 (KV rms)
Max. operating conductor Temperature	-	90 deg. C
Max. conductor temperature under short circuit for 1 Sec.	-	250 deg. C.

5.01.00 CONSTRUCTION OF CABLE :

66kV, 630sqmm, Single Core XLPE insulated lead sheathed cable.

A) Lead sheathed cable :

Construction : 38/66KV (Earthed), single core 630sq mm Stranded annealed copper conductor, segmental, compact, circular, circular conductor screen, cross linked polyethylene (XLPE) insulation, core screen, semi-conducting water swellable layer, lead alloy 'E' sheathed, semi conducting bedding tapes, helically applied plain round copper wire screen, plain copper tape in open helix, water swellable tape with overall extruded high density polyethylene sheath, coated with graphite.

Conductor	Plain annealed high conductivity copper wires stranded, segmental conductor (circular Conductor) conforming to IEC-60228.
Conductor screen :	Extruded semi-conducting layer.
Insulation :	Dry cured cross linked polyethylene. Nominal thickness 12.00 mm Minimum thickness : t ((min)≥ 0.9 t_n And $\frac{t_{max} - t_{min}}{t_{max}} \leq 0.05$

Where t_{max}, t_{min} and t_n are respectively the minimum, maximum & nominal thickness

Core/Insulation Screen	: Extruded semi-conducting layer
Core/Insulation Screen	: Ovality of Core $\frac{Dmax - Dmin}{Dmax} \leq 0.02$ Where D = Dia of core over extruded semiconducting layer
Longitudinal water barrier	: Semi-conducting water swell able tape/s.
Radial Moisture Barrier	: Extruded lead alloy 'E'. The minimum thickness of the metallic sheath shall not fall below 95% of the nominal thickness by more than 0.1 mm. t min.≥ 0.95tn – 0.1
Bedding	: Semi-conducting tape/s.
Armour/Screen	: Helically applied non-magnetic plain copper wires.
Contact tape	: Annealed plain copper tape in open helix.
Water swellable tape	: Non-conducting water swellable tape.
Outer sheath	: Extruded High density polyethylene type ST 7 (Yellow), anti-termite treated with coating of colloidal graphite.

6.00.00 GENERAL TECHNICAL REQUIREMENTS OF THE CABLE :

The size of the conductors of the cable shall be sufficient to carry continuously **600 Amps** followed by a **20%** overload for three hours without exceeding a maximum temperature of 90deg C under site conditions. The OWNER estimates that a cross section of 630sqmm circular conductor would be adequate to carry the stipulated load current.

The conductor size shall be based on loading of the circuit under the conditions indicated in Clause- 3.00.00 & 4.00.00 above.

6.01.00 INSULATION CURING:

Dry curing process should be adopted in cross-linking the insulation.

6.02.00 TRIPLE EXTRUSION:

The conductor screen, insulation and insulation screen shall be extruded in single operation simultaneously during manufacture (Triple Extrusion). The cross linked polyethylene insulated (XLPE) cable (dry cured) shall be manufactured in accordance with the internationally accepted standard and also conform to the requirements of IEC: 60840 for rated voltages from 30kV to 150kV.

6.03.00 DESIGN STRESS AND INSULATION THICKNESS:

The recommended design stress values for insulation thickness are :

Design stress a.c. : **20 KV/mm**

Design stress impulse : **50 KV/mm**

The higher of the two values of the insulation thickness will be adopted but not less than the nominal value of 12.00 mm.

6.04.00 DIELECTRIC STRESSES:

The 66kV cable shall be designed for continuous operation at a maximum line to earth system voltage of 38kV. The maximum dielectric stress at the conductor screen and insulation screen shall not exceed the following:

For 630 sqmm

a) At conductor screen **4.8 KV/mm**

b) At insulation screen **2.4 KV/mm**.

The dielectric stress at 38kV shall be furnished by the Bidder with calculation sheet.

6.05.00 The cable shall be designed to have a minimum useful life of not less than fifty years. The cable manufacturer should submit a graph showing the breakdown voltage with respect to time for the XLPE insulation compound used. In addition the type of XLPE semi-conducting compound used should be indicated i.e., whether super smooth and purity level.

6.06.00 Each cable length shall be provided with a pulling socket, pulling eye, which shall be fitted to pulling end to withstand the maximum pulling force.

6.07.00 Copper wire screening shall be preferably before the lead sheath to ensure specific water tightness of cable both transversely and longitudinally.

However other types of placement of the copper wire screening is also acceptable if it meets the overall technical requirements. The same shall be established by way of Type Test Reports conducted on such cables.

6.08.00 CURRENT RATING:

The Bidder shall furnish the continuous current ratings in ground, in air, in pipes and in ducts at the maximum conductor temperature of 90 deg C with reference to the ambient site conditions on the guidelines of IEC 60840. Any additional data,

other than furnished under climatic conditions and operating conditions may be suitably assumed. However the same shall be furnished in GTPs for reference. The ratings shall be for trefoil touching when the sheaths are single point bonded and both ends bonded or cross bonded (without exceeding the stipulated voltage 65 volts or undue high circulating currents).

The current ratings shall be for single circuit/double circuit in operation.

The bidder shall also furnish technical information on:

1) Derating factors for various types of installation conditions in trefoil and flat (viz., depth of laying, varying ground temperatures, cables in ducts/pipes, cable spacings, circuit spacing, varying soil thermal resistivity's etc.) shall be furnished by the bidder for the following conditions:

   (a) Proximity to other EHV cables.

   - Variation of number of cables (max. 12 in number).
   - Variation in spacing.
   - Variation in loading of the cables (80% to 100%)

   (b) Variation in depth of water table

   (c) Depth of laying cables in trenches and cable ducts.

   (d) Depth of Stabilized Thermal Backfill (STB) below and above laid cables

   (e) Width of trench on either side of the cables in which STB will be put

   (f) Variation in STB effective thermal resistivity

   (g) Variation in soil thermal resistivity.

   (h) Laying of cables in long lengths of HDPE pipe, 19mm thick- Variation due to size and thickness of pipe and open space available in pipe – BIDDER shall suggest methods to improve the ratings.

2) Short Time current Loading:

   The current loading permissible for a defined period of short time operation, over the cyclic load as under.

   Cyclic Loading over a 24 hour period.

2100 to 0600 Hours	(9 Hours)	50%
0600 to 0900 Hours	(3 Hours)	120%
0900 to 1800 Hours	(9 Hours)	100%
1800 to 2100 Hours	(3 Hours)	120%

   Furnish short time loading for the following conditions.

   i) Only one cable circuit is live.

   ii) When both circuits are live

   When cables are laid in Trefoil touching.

   i) Single point bonded.

ii) Both end bonded.

iii) Cross bonded.

The Bidder should furnish GA drawing/Other details with supporting calculations on charging current, capacitance, inductance, losses, sheath voltages, sheath currents, surge impedance, sequence impedance and screen factors, detailed drawing etc., shall be furnished along with the bidding documents.

6.08.01 MECHANICAL CHARACTERISTICS OF CABLE:

The cable shall withstand the electromechanical forces due to short circuit currents of **40KA** and shall withstand the stresses in the insulation due to faults. The cable shall withstand the mechanical stresses during installation.

6.09.00 TEMPERATURE RISE:

The maximum conductor temperature shall not exceed 90deg C during continuous operation at full rated current at 66 kV followed by 20% overload for three hours. The temperature after a short circuit for one second shall not exceed 250deg C, with initial conductor temperature of 90deg C.

6.10.00 EMERGENCY LOADING:

The BIDDER shall indicate the maximum percentage overload current that the cable can carry and its duration when operating initially at a conductor temperature of **90deg C** and permissible final conductor temperature after overload. The total period during the lifetime of the cable when it shall be subjected to emergency loading without affecting the expected life of the cable shall also be indicated.

6.11.00 CYCLIC RATING:

The BIDDER shall also indicate the percentage overload current that the cable can carry and its duration, without the conductor temperature exceeding **90deg C** due to the time lag in conductor temperature change on account of the change in thermal characteristics of the mass of the soil surrounding the cable.

6.12.00 CABLE MATERIAL:

a) CONDUCTOR:

The conductor shall be of plain annealed copper wires, compacted, circular, Stranded conforming to IEC-60228. The copper used for the conductor shall be of highest purity. The minimum number of wires and conductors and DC resistance of conductor shall be as per IEC-60228.

b) CONDUCTOR SCREEN:

The conductor screen shall be provided over the conductor by extrusion of semi-conducting compound or by a combination of semi-conducting tape/s and extruded semi-conducting compound. The minimum thickness, excluding tape/s shall be 0.8 mm.

c) INSULATION:

Cross linked polyethylene insulation by dry curing process shall be provided over the conductor screen. The nominal thickness of 12.00 mm (It is the minimum thickness stipulated. However, thickness is required to be increased so that the stress values and dielectric stress level shall be within the limits as stipulated at Cl.No.6.03.00 & 6.04.00) and subject to tolerance as per IEC – 60840, clause 10.6.2.

The insulation shall be of high quality, and shall be as for as possible free from contaminants, moisture and voids. The size of the voids and contaminants shall be within limits of recognized national /IEC standards.

The insulation shall be suitable for operation in wet or dry locations at conductor temperature not exceeding 90 deg. C for normal operation, 130 deg. C for emergency overload of short duration, and 250 deg. C for short circuit conditions.

d) INSULATION SCREEN

Shall be extruded semi-conducting compound and of minimum thickness 0.8 mm

The semi-conducting screens shall be suitable for the operating temperatures of the cable and compatible with the insulation.

e) **Moisture Barrier (Longitudinal):**

This shall be semi-conducting synthetic non-woven tape / yarn with suitable swellable absorbent for longitudinal water sealing covering the whole surface area of the non-metallic part of insulation screening. This barrier shall restrict longitudinal water penetration under the metallic sheath. The nominal thickness of water blocking tape shall not be less than 0.3 mm.

f) **Metal Sheath/Moisture Barrier (Radial):**

Shall be extruded lead alloy 'E' sheath.

The nominal thickness of lead alloy sheath shall be 3 mm and shall meet the Electrical and Mechanical properties as per standards.

The minimum thickness shall be as per IEC 60840 (Clause 10.7.1)

g) **Bedding Tapes:**

Suitable semiconducting bedding tapes shall be used under metallic screen of approximate thickness 0.3 mm.

h) Metallic Screen (Armour):

The metallic screen shall be of plain copper round wires, helically applied over the semiconducting bedding tape/s.

A binder tape of suitable material/annealed plain copper shall be applied in the form of an open helix, over the metallic screen.

Note: Requirement of Metallic Sheath/Screen:

The metallic screen can be before or after lead sheath. However it shall be as per the manufacturer's type tested design.

The cross section of the metallic sheath that is lead sheath in combination with bronze tapes/plain copper round wire screen shall be designed to meet the following requirements:

(i) Sustaining the system short circuit rating of 40kA for 1 Sec.

The temperature of metallic sheath at the time of short circuit (cable operating at maximum conductor temperature) shall be indicated in the short circuit calculations of the design of metallic screen/lead sheath.

(ii) Ensuring mechanical protection of the cable.

(iii) Ensuring radial water tightness of the cable.

Note: Test report ensuring the above compliance has to be submitted by the bidder along with the bid.

i) **Outer Sheath:**

The outer sheath shall be extruded yellow colour High Density Polyethylene, type ST 7 conforming to requirement of IEC. The High Density Polyethylene compound used shall be brand new from a reputed manufacturer and in no case shall recycled material be used.

The outer sheath shall be designed for protection against termite and rodent attack by adding suitable additives to HDPE compound, which are harmless to operating personnel.

j) **COATING:**

A hard baked on layer of graphite shall be applied over the sheath as outer electrode for testing the sheath.

6.13.00 IDENTIFICATION:

The following information shall be embossed on the outer sheath of the cable continuously repeated throughout the length of the cable

(i) Brand name of manufacturer

(ii) Year of Manufacture.

(iii) Voltage rating/Conductor cross section ; 66000V/ 630 sq. mm.

(iv) KPTCL/BMRCL.

(v) The UG cable shall be embossed for every 1meter throughout the route length of the cable

7.00.00 CABLE ACCESSORIES:

7.01.00 GENERAL:

The following are the accessories required.

a) The straight through normal joints suitable for directly buried in ground conditions.

b) Outdoor type cable end terminations./ GIS Module - Plugin - Type

The above accessories shall be suitable for the 38/66kV 630sqmm, single core copper conductor lead sheathed sheath cable. The detailed cable construction is given in these specifications under clause 5.01.00.

7.02.00 TECHNICAL REQUIREMENTS:

The accessories should be compatible with size of the conductor, the insulation and the voltage class of the cable. The components of the accessory shall not be affected by contact with the component materials of the cable, and shall not corrode any metal, which they come in contact. The accessory, in the assembled condition, shall be capable of operating under the normal and fault temperature conditions of the cable.

The cable accessories should be procured only from reputed manufacturers and type test reports shall be submitted along with the bid.

7.02.01 STRAIGHT THROUGH JOINT:

The straight through joints shall be suitable for 66 KV single core, 630 sq.mm Copper conductor, lead sheathed XLPE cable and conforming to relevant IEC specification.

The joints shall be suitable for size of the conductor, the insulation, voltage and current ratings of the cable. The required service conditions are horizontal installation, directly buried in earth, laid in RCC cable duct and intermittently or continuously submerged in water.

The BIDDER shall quote for the required quantity of prefabricated type straight joints which shall comprise of a Factory Tested One Piece Pre Moulded Silicone Rubber joint body Moulded from a special Silicone Rubber formulation to provide perfect compression force for optimized electrical performance and afford very simple, reliable, consistent installation. Conductor Jointing should be either with mechanical connectors or a proven crimping technique. Outer mechanical protection with integrated moisture protection must be provided and the manufacturer must provide a detailed description of this. Solderless Jointing

technique for the lead sheath and copper wire screen must be provided. Further, the straight through joint shall be able to

i) Provide a seal against the entrance of moisture or external environment.

ii) The assembled joint should be resistant to corrosive agents present in the soil, should be mechanically strong to withstand pressure, bending, pulling fatigue. The joint should withstand temperature variations under normal load and fault conditions.

Heat shrinkable type joints are also acceptable and the design of the Joint shall take care of to provide the stress control for the shield terminal, current rating and thermal stress.

7.02.02 OUT DOOR CABLE END TERMINATION:

The cable end terminations shall be out door self supporting type suitable to 66KV SC, 630 sq.mm Copper conductor, lead sheathed XLPE cable and shall conform the relevant IEC.

The outdoor termination should have a device for electrical stress control at the end of screen/shield. It should avoid partial discharges and surface corona under the service conditions. It should seal any ingress of atmospheric elements. The total creepage distance shall not be less than 1850 mm.

The outdoor termination shall be suitable for insulation, voltage, conductor size and current rating of the cable.

The service conditions are:

Outdoor installation with usual and unusual supporting structure (ie., directly on transmission towers with lightning arrestors), heavily polluted atmosphere. The minimum total creepage distance for the termination shall be 1850 mm. The termination should be directly exposed to solar radiation and precipitation.

Cable terminations – sealing end *pre-fabricated /* pre-moulded type (*preferably* Silicon Insulators are required for outdoor cable end terminations). The sealing ends shall conform to the latest International Standards and shall be of thoroughly proven design. The internal electric stress in the sealing end shall be controlled by the pre-moulded cone arrangement and all other accessories. The cable terminations shall be outdoor type. **Heat shrinkable type outdoor terminations are also acceptable and the design of the termination shall take care of to provide the stress control for the shield terminal, current rating and thermal stress.** The outdoor type sealing ends shall be suitable for installation in polluted atmosphere referred to in clause 4.00.00 and shall be completely weather proof. Each outdoor type-sealing end shall be supplied complete with mounting plate insulators to insulate the sealing end from the

supporting structures and to control the sheath current. If required, terminal connectors and bimetallic clamps shall also be supplied. Each sealing end shall be provided with consumable materials such as wiper and solvent for cleaning. The power cable leading to sealing end shall be provided with proper sunshield cover with flexible PVC pipe.

The materials for the housing of the termination should be resistant to tracking, ultra violet radiation (U.V. Exposure) weathering and should have stable hydrophobic properties.

The Bidder shall provide necessary arrangement to limit flow of current in the structure supporting the sealing end.

The sealing ends shall withstand the power frequency, impulse and cable testing voltage after installation as specified.

The cable and accessories shall withstand all thermal and mechanical stresses under steady state and transient operating conditions.

7.03.00 TECHNICAL ASSISTANCE / TRAINING:

The contractors shall arrange with the suppliers of cable joints and/or termination, the technical assistant in jointing/ terminating the cable during installation at the site. The contractor shall arrange to train the owner's personnel in jointing and terminating techniques during the installation.

7.04.00 LINK BOXES FOR EARTHING:

7.04.01 **Link Boxes along the run of the Cable:**

a) Link boxes for grounding of the sheaths of single core cables along the run of the cables shall be made of cast iron/aluminum alloy/stainless steel, suitable for direct burial in the same ground conditions as the cable with anti-rust protection suitable for completely underground installation and for operation when immersed in water. The link box shall conform to IP-66 degree of protection for which the test reports shall be furnished. The design of the box must include a top Lid, which can be lifted vertically. BIDDER to submit the detailed drawing of these boxes along with the Bid. These Link Boxes shall be easily accessible from road surface in case of installation in joint pit. The box shall ensure complete water tightness.

b) These Link Boxes shall be suitable for terminating the cable sheaths on either side of joint bays based on cable route for cross bonding at the box as well as for earthing at recommended locations.

c) All accessories such as copper terminals, cable lugs, connecting links, disconnecting links, washers, gaskets, mounting arrangements, etc., shall be provided to make the system complete.

d) The cross bonding link box shall be designed to be completely water proof and capable of immersion in water.

e) The cable leads from sheath to link box capable of withstanding 10 kV DC and cable leads from link box to earth shall also be in BIDDER's scope of supply. The BIDDER shall quote for the type of cable leads for the cross bonding system and for earthing.

Non –linear resistor type surge divertors of metal oxide type, wherever required, shall be provided in the link box by the BIDDER.

f) The BIDDER may quote for link boxes of suitable design in which the surge voltage limiters (SVLs) do not need to be disconnected when a routine 10 kV DC test on the cable oversheath is performed.

7.04.02 **Link boxes at the circuit end**:

The lead sheath shall be grounded through suitable disconnecting links at the base of sealing ends. The BIDDER shall clearly indicate whether the links are to be grounded directly or through SVLs (non-linear resistors). The links shall be housed in a weather proof, outdoor, galvanised sheet steel box or cast iron or aluminium alloy box with mounting brackets and provided with 'O' Ring gasketed door. The cable leads from the sheath to the link box, capable of withstanding 10 kV DC and cable leads from link box to earth shall form a part of the scope of supply of the BIDDER. The Bidder shall quote for the same.

7.04.03 **Cross Bonding of cable sheath**:

The BIDDER shall give his recommendations regarding cross bonding of cable sheaths for the trefoil formation of single core cables. The BIDDER shall clearly indicate the number of joints to be directly earthed and those to be earthed through zinc oxide (Z_nO), non-linear resistors (sheath voltage limiters). The offer may indicate a suitable design whereby Z_nO resistors need not be disconnected while conducting routine DC test on the over sheath.

The sheath voltage to earth for rated cable current shall not be in excess of 65 V RMS.

The sheath voltage, during an external three phase, symmetrical through fault as specified, should not be in excess of 2.6 KV for 3 sec.

The BIDDER shall indicate the arrangement considered by him in his proposal to meet the above requirements with suitable non-linear resistors, if required, to limit the sheath voltage.

Detailed calculations for sheath voltages as per recommended bonding methods shall be furnished along with the bid.

The BIDDER shall indicate any special arrangements at the link boxes for audible (alarm) indication and annunciation of the sheath currents in the Control Room.

The BIDDER shall indicate permissible variation in the lengths of the 3 minor sections of a major section, which will not affect the efficacy of the cross bonding.

The BIDDER shall confirm that the cable can be continued in service in the event of a sheath fault and shall indicate the de-rating of the cable in case of an earth on the sheath at the link box earthed through SVLs.

The BIDDER shall indicate and provide arrangement for transposition of cables if necessary along with cross bonding. The details of the same shall be furnished along with the bids.

7.04.04 The BIDDER shall make adequate provision for installation of temperature transducers in all the joints of the 66 kV cables. They shall be suitable for utilization in conjunction with a numerical distance scheme with cable fault locator to be installed in the Control Room. This shall be quoted as an optional item in Price Bid. All the technical details along with supporting documents shall be furnished.

7.04.05 The BIDDER shall make adequate provision for installation of thermocouples at selected hot spots, critical locations on the cable over sheath along the routes and shall indicate the correlation between over sheath temperature and conductor temperature. BIDDER shall indicate a suitable scheme for remote transmission of the monitored temperature values over the auxiliary pilot cables to be provided by the OWNER.

Alternatively instead of auxiliary pilot cables optic fibre may be provided along with the cable. These shall be quoted as an optional item in price bid.

7.05.00 SHEATH BONDING CABLE AND EARTHING CABLE:

The sheath bonding cable shall be Co-axial cable 6.6kV and above grade with 240/240 sq. mm (conductor/concentric conductor) stranded copper conductor PVC insulated wire armoured & PVC sheathed.

The earthing cable shall be 3.3kV & above grade with 240sqmm stranded copper conductor PVC insulated & PVC sheathed. However, the rating size of sheath bonding cable & earthing cable mentioned is indicative & are minimum values. The bidder may quote actual rating & size of cable offered, to meet the requirements.

7.06.00 PIPE EARTH STATIONS:

The earthing shall be as per provisions of IS : 3043 : Code of practice for earthing and as per IE rules : 1956 or its latest amendments.

8.00.00 A. **ELECTROLYSIS AND CORROSION:**

The cable serving shall be designed such that the cable sheath and armouring are protected from electrolysis caused by stray currents, from galvanic action and from corrosion and microbiological attack. The design of accessories shall be such that the outer metallic coverings of cable joints, sealing ends and control points can be insulated from earth along the entire route so that cathodic protection, if needed can be applied and also periodic testing of the insulating resistance of the serving can be done. A set of links shall be provided at each end of cables to connect the cable sheath and armour to the respective station grounds. The sealing ends shall be suitably insulated from their supporting structures, to permit insulation test on the cable oversheath.

B. **GROUNDING SYSTEM**:

The BIDDER shall indicate his recommendations regarding the type of grounding systems for the lead sheath/armour. The scope of supply shall include ground rod or ground conductor as recommended. The grounding material shall be copper.

9.00.00 **TESTS ON CABLES AND ACCESSORIES:**

9.01.00 **APPLICABLE STANDARDS:**

The testing procedures and requirements shall conform to the latest edition of the following national and international standards, but not limited to:

a) IEC publication 60540
b) IEC publication 60228
c) IEC publication 60229
d) British Standard Specification 6622
e) IEC publication 60840 (only applicable), 4th Edition 2011
f) IEC publication 60230
g) IEC publication 60287
h) IEC publication 60811
i) IEC publication 60885
j) IEC publication 62067

The IEC Standards shall prevail whenever the same tests are specified in other standards.

9.02.00 **TESTS**

9.02.01 The bidder shall include the field test report of similar size and voltage class cables installed in actual service. The report shall include voltage class, size,

actual voltage, actual load current data, sheath voltage, sheath/conductor temperature data and all events after installation during service of such cable till date etc.

9.02.02 Type tests shall mean those tests, which are to be carried out to prove the process of manufacture and general conformity of the material to this specification. These tests shall be carried out on samples prior to commencement of commercial production against the order. The Bidder shall indicate his schedule for carrying out these tests in the activity schedule.

9.02.03 Acceptance tests shall mean those tests, which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of the lot.

9.02.04 Routine Tests shall mean those tests, which are to be carried out on each strand/spool/length of the cable to check requirements, which are likely to vary during production and to demonstrate the integrity of the cables to be delivered to the customers for use.

9.02.05 Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Bidder to ensure the desired quality of the end product to be supplied by him.

9.02.06 The Standards and norms to which these tests will be carried out are mentioned elsewhere in these specifications. Where a particular test is a specific requirement of this specification, the norms and procedures of the test shall be mutually agreed to between the Bidder and the Owner in the Quality Assurance Programme.

9.02.07 For all type and acceptance tests, the acceptance values shall be the values guaranteed by the Supplier in the proforma for "Guaranteed Technical Particulars", furnished in this Specification or acceptance value specified in this specification, whichever is more stringent for that particular test.

9.02.08 All tests – routine, acceptance and type tests shall be as per IEC-60840 and latest amendments.

9.02.09 The adequacy of Partial Discharge detector used for Partial Discharge tests required for drum lengths of cables under routine tests must be demonstrated by performing tests as per IEC-60885 (3) – 1988.

The bidder shall furnish a copy of type tests certificates for the cable and accessories offered as per the specification from any of the following laboratory on similar cable and accessories as offered for this tender. The test should have been conducted within the last 5 years. The bids without type certificates are liable for rejection. No charge is payable by the owner for the type tests.

a) Central Power Research Institute, Bangalore.
b) CESI(Italy).
c) KEEMA (Holland)
d) F.G.H. (Germany).
e) CERL (UK).
f) EDF (France)
g) KERI, South Korea
h) IPH Berlin –Germany

Following are the type test reports which are to be enclosed/uploaded in the bid.

a. Electrical Type tests as per – (Cl. 9.04(a) i to ix of specification)
b. Non-Electrical Type tests as per – (Cl. 9.04(b) i to x of specification)
c. Special test as per – (Cl. 9.07(a) (i) to (iv) of specification)
d. Type test for Link box – (Cl. No. 7.04.01 of specification)

9.03.00 TYPE TESTS TO BE CONDUCTED DURING THE SUPPLIES/AFTER COMPLETION OF SUPPLIES FOR ACCEPTANCE OF CABLE AND ACCESSORIES AT THE DISCRETION OF THE OWNER:

1) CABLE :

The owner will select at random a test sample of cable from the lot and subject it to **either a particular type test or** full range of type tests as per IEC-60840: 2011 at any reputed testing house or Laboratory or at manufacturer premises to be approved by KPTCL.

The bidder shall prepare the sample for tests and organize testing.

The type test/s will be conducted at Owner's cost.

However, the bidder shall make arrangements for transportation of test samples from manufacturing unit to the Test Laboratory indicated by owner at his cost.

The applicable type test charges for only to such tests to be conducted as per owner's instructions will be payable by the Owner (Refer Note (e) given below).

If the cable fails in any of the type tests, the entire lot of cable will be rejected.

1) JOINTS & TERMINATION:

Two Terminations and one joint will be selected at random out of the supplies and subjected to **either a particular Type test or** full range of type and other tests at any reputed testing house/laboratory to be approved by KPTCL as per Clause IEC 60840: 2011 and tests shall be carried out accordingly.

The bidder shall prepare the sample for tests and organise testing. The type test/s will be conducted at Owner's cost.

However, the bidder shall make arrangements for transportation of test samples from manufacturing unit to the Test Laboratory indicated by owner

at his cost.

The applicable type test charges for only to such tests to be conducted as per owner's instructions will be payable by the Owner (Refer Note (e) given below).

If the sample under test i.e., cable / joint / termination fails, the entire lot of cable / joint / termination will be rejected.

2) The tests mentioned in (1) & (2) above are independent of the type test reports already furnished by the supplier.

NOTE:

a) The waival of any type tests shall be at the sole discretion of the owner.

b) The successful bidder/vendor shall provide the associated cable and testing material for tests at his own cost.

c) The cost towards **each** type test shall be clearly indicated **separately** in the bid and the same will **not** be included for bid evaluation.

d) The owner may modify tests by including additional tests or delete certain tests at his discretion.

e) The test charges would be paid by the owner only for such tests that are conducted successfully in a third party lab other than manufacturer lab. If the tests are conducted at Manufacturer lab no charges would be paid for such tests. However, the bidder has to quote for such tests. And in case of failure of the test material, the entire lot of cable/joint/termination will be rejected.

The type test charges shall be paid upfront by the firm/bidder even though the same is on the behest of KPTCL. However such type test charges as per actuals shall be reimbursed to the firm/bidder in case the cable passes the type tests successfully. Type test charges will not be reimbursed if the cable fails in the type test.

9.04.00 TYPE TEST ON CABLE SYSTEM (CABLE & CABLE ACCESSORIES):

The following type tests comprising the electrical tests on the completed cable and the appropriate tests on the cable components shall be conducted in any independent test house or at manufacture's works in the presence of the owner's representative.

The owner may at his discretion, waive the type tests, modify the tests, request for additional tests.

1) The type tests and sequence of electrical test (as per IEC 60840/2011) on completed cable system shall be :

a) Bending Test on the cable (Cl.12.4.3) followed by installation of accessories and a partial discharge test at ambient temperature (Cl.

12.4.4)

b) Tan & measurement (Cl:12.4.5)

c) Heating cycle voltage test (Cl:12.4.6)

d) Partial discharge test (Cl:12.4.4)

- at ambient temperature, and
- at high temperature.

The tests shall be carried out after the final cycle of item (c) above or alternatively, after the lightning impulse voltage test in item (e) below.

(i) Lightning impulse voltage test followed by a power frequency voltage test (Cl.12.4.7)

(ii) Partial discharge tests, if not previously carried out in item (d) above.

(iii) Tests of outer protection for joints (Refer annexure G):

(iv) Examination of the cable system with cable and accessories on completion of the above tests (Cl. 12.4.8)

(v) The resistivity of the cable semi-conducting screens (Cl. 12.4.9) shall be measured on a separate sample.

2) The Non electrical type tests on cable components & on completed cable (as per IEC 60840/2011 CL No. 12.5) shall be:

a) Check of cable construction (Cl. 12.5.1)

b) Tests for determining the mechanical properties of insulation before and after ageing (Cl. 12.5.2)

c) Tests for determining the mechanical properties of oversheaths before and after ageing (Cl. 12.5.3)

d) Ageing tests on pieces of complete cable to check compatibility of materials (Cl. 12.5.4)

e) Pressure test at high temperature on oversheaths (Cl. 12.5.6)

f) Hot set test for EPR and XLPE insulations (Cl. 12.5.10)

g) Measurement of density of HDPE insulation (Cl. 12.5.11)

h) Measurement of carbon black content of black PE oversheaths (ST3 and ST7) (Cl. 12.5.12)

i) Test under fire conditions (Cl. 12.5.13)

j) Water penetration test (Cl. 12.5.14)

k) Tests on components of cables with a longitudinally applied metal tape or foil, bonded to the oversheath (Cl. 12.5.15)

l) Shrinkage test for PE, HDPE & XLPE insulations (Cl. 12.5.16)

m) Shrinkage test for PE, oversheath, ST_3 & ST_7 (Cl. 12.5.17)

9.05.00 ROUTINE TESTS ON CABLE:

The following tests as per IEC – 60840/2011 shall be carried out on each length of cable and:

a) Partial discharge test (Clause 9.2)
b) Voltage test (Clause 9.3)
c) Electrical test on over sheath (non-metallic sheath) of the cable (Clause 9.4)
d) Conductor resistance test (Clause 10.5)

9.06.00 ACCEPTANCE TEST ON CABLE:

The following tests as per IEC – 60840/2011 shall be carried out on samples.

a) Conductor examination (Clause 10.4)
b) Measurement of electrical resistance of conductor and of metal screen (Clause 10.5)
c) Measurement of thickness of cable insulation and over sheath (Clause 10.6)
d) Measurement of thickness of metal sheath (clause no. 10.7)
e) Measurement of diameters (Clause no. 10.8)
f) Hot set test for XLPE insulation (clause no. 10.9)
g) Measurement of capacitance(clause 10.10)
h) Measurement of cross sectional area of cable screen (Copper wires)
i) Water penetration test if applicable (Cl. No. 10.13)
j) Tests on components of cable with longitudinally applied metal tape or foil, bonded to the over sheath (Cl. 10.14)

Frequency of acceptance test :

The acceptance tests shall be conducted on one drum length from each manufacturing series of the same type and size of cables, but shall be limited to not more than 10% of the number of drum lengths, rounded to upper unity.

9.07.00 (A) **SPECIAL TESTS ON CABLE:**

(a) The following are the additional special tests:
  (i) Water absorption test (Gravimetric method) on XLPE as per IEC- or equivalent standard.
  (ii) Short circuit test on metallic wire screen and lead sheath in combination at 40kA for 1 sec with conductor temperature during the test at 900C
  (iii) Test for e of the core (The requirement shall be conforming to IS-7098 (Part III))
  (iv) Test on concentric metallic screen
    (i) Tests for concentric copper wire.
    (ii) Tests for concentric copper tape.

(iii) Test for combined electrical resistance of copper wire screen and metallic sheath.

Note:

(a) The waival of type tests shall be at the sole discretion of the owner.

(b) The successful bidder/vendor shall provide the associated cable and testing material for tests at his own cost.

(c) The cost towards type tests shall be clearly indicated in the bid and will **not** be included for bid evaluation.

(d) The owner may modify tests by including additional tests or delete certain tests at his discretion.

(e) The test charges would be paid by the owner only for such tests that are, conducted successfully in a third party lab other than manufacturer lab. If the tests are conducted at Manufacturer lab no charges would be paid for such tests. However, the bidder has to quote for such tests. And in case of failure of the test material, the entire lot of cable/joint/termination will be rejected.

9.07.00(B) TESTS ON CABLE ACCESSORIES:

The supplier shall conduct the test on cable accessories to prove the general qualities and design of given types and the following type tests in sequence for joints and terminations as per IEC – 60840/2011 (Cl. 15.3)

(a) Partial discharge test at ambient temperature (Cl. 12.4.4)

(b) Heating cycle voltage test (Cl. 12.4.6)

(c) Partial discharge test (Cl. No. 12.4.4)

- At ambient temperature and
- At high temperature.

The test shall be carried out after the final cycle of (b) above or alternately after the impulse voltage test in (d) below.

(d) Lightning Impulse voltage test followed by Power Frequency. voltage test (Cl. 12.4.7)

(e) Partial discharge test if not previously carried out in (c) above.

(f) Test of outer protection for buried joints (Annexure G).

(g) Examination of the accessories after completion of the above tests (Cl. 12.4.8.1)

Tests (a) to (e) shall be applied successively to each test loop. Test voltages shall be in accordance with the values given in the appropriate column of Table (4) of IEC – 60840.

Test (f) shall be applied to a joint which has passed test (b) heating cycle voltage test or to a separate joint, which has passed at-least three thermal cycles.

9.07.01 SPECIAL TEST ON ACCESSORIES

9.07.02 JOINTS

Cyclic ageing test under water.

The joint should meet the requirement of cyclic ageing in water test, that is joint immersed in water of 1 M head and subjected to 30 load cycles, each load cycle of 24 hr. times span, at elevated temperature and at twice the rated AC voltage continuously during the 24 Hrs. cycle.

The detailed test procedure shall be as per relevant IEC and IEEE standard 404-1993

9.07.03 OUTDOOR TERMINATION:

The outdoor termination should meet the following additional test requirements

i) Power frequency voltage wet withstand test as per standard IEE 48-1996 /IEC 60840
ii) Salt fog test as per IEC
iii) Material test (if applicable)
   (a) Tracking and erosion resistance
   (b) Thermal ageing
   (c) Weather resistance

9.07.04 ADDITIONAL TESTS:

Following tests shall be carried out as per IEC-60840 on the complete installation after completion of cable laying, jointing and providing all necessary accessories.

a) Insulation resistance test.
b) DC voltage test of over sheath & AC voltage test of the insulation in accordance with IEC-60840. (Cl. 16.2 & 16.3)
c) Site tests on non-metallic sheaths in accordance with IEC-60229.
d) Test for detection and sealing of pin holes.
e) Sheath voltage test.

The supplier shall also indicate any additional special test at site recommended by them to ensure satisfactory operation.

9.08.01 The supplier shall furnish all the testing details in a compact disc.

10.00.00 IDENTIFICATION

The cable should be identified by embossed letters in English as per clause 6.13 of Technical specification. The accessories shall be marked with voltage class, size of the cable conductor, manufacturer's name or trade mark, date of manufacture and relevant technical information.

10.00.01 **GUARANTEED LOSS:**

(i) The bidder shall clearly indicate the guaranteed value of the losses (at a maximum of two decimal places only) which **shall be firm and without any tolerance limit** in respect of under mentioned types of losses, as required in Schedule-14 at rated current, voltage & frequency **per circuit KM (all 3 phases put together in one KM length of cable) in KW only**.

(a) Dielectric losses
(b) Conductor/Copper losses.
(c) Sheath losses.

(ii) The Guaranteed values of these losses quoted by the bidder will be taken for capitalizing the losses at the rates indicated below wherein the quoted prices shall be loaded by the differential capitalized loss amount for the purpose of bid comparison. For fraction of a KW quoted, capitalized cost of losses shall be calculated on pro-rata basis.

1	Capitalized Cost of Dielectric Losses	**Rs.4,53,000/- per KW.**
2	Capitalized Cost for Conductor/Copper loss and sheath loss.	**Rs.1,85,000/- per KW.**

(iii) For the purpose of evaluation of the offer, the lowest individual losses/CKM quoted for each type of losses by any bidder shall be taken as the basis to work out the deviation in quoted losses by any particular bidder. No rounding-off of any value will be done and Loss values will be reckoned up to TWO decimal places only. The bid price would then be enhanced by the differential capitalized amount for the purpose of comparison of bids.

(iv) The cable losses guaranteed in the bid are to be supported by design calculations along with documentary evidences if any, as per procedure & formula stipulated in IEC 60287-1-1 with latest amendments thereof. The reference of the same along with an extract of applicable IEC Standard shall be clearly furnished along with the GTP ***without which the bid would summarily be rejected.***

(v) The value of loss factor of the XLPE insulation (tan δ) shall be as per IEC 60287-1-1 i.e., 0.001. This value shall be taken for calculation of dielectric losses/evaluation. No upper tolerance limit would be allowed for this value. However bidder can supply cables of tan delta values lesser than 0.001

(vi) The current in the conductor (I), for computation of conductor/copper loss shall be the rated continuous current in ground, as per clause no. 4.00.00

BI (11) (ii) of Technical specification of cable. The AC resistance of conductor (R_{ac}), at the **said rated continuous current in ground** shall be considered for calculation of copper losses. All cable parameters considered for loss calculation shall be as per the values declared by the bidder in the GTP. Any assumptions/ Omissions in the Formula used for detailed loss calculation as per the above IEC shall be invariably indicated in the GTP.

(vii) In case the declared guaranteed/quoted losses are in deviation to the losses arrived as per calculation, the higher of the two would be considered for evaluation of the offer and the lower of the losses would be considered for acceptance of the cable.

(viii) On testing, if it is found that actual losses are more than the values guaranteed/quoted in Schedule-14, penalty shall be recovered from the bidder at the rates ***triple the capitalization cost*** indicated under sl. no. (ii) above. However, no incentive would be allowed if the actual losses are found to be less than the guaranteed/quoted values.

(ix) The cable would be accepted only if the measured values/test values/actual values on the finished product (on testing) is found to be within +5% of the guaranteed/quoted values for each type of losses subject to recovery of penalty as stated in sl. no (viii) above. In case the measured value is exceeding the limit of 5% in any type of these losses, the cable would be out rightly rejected.

(x) The guaranteed values of the losses quoted by the successful bidder will be verified at the time of final acceptance of the material after conducting necessary Tests on a random sample/s of the material taken from the finished product. The Tests shall be conducted in the laboratories as per terms and conditions as noted elsewhere in the tender documents.

11.00.00 QUALITY ASSURANCE PLAN:

a) The bidder shall invariably furnish the following information along with his offer failing which the offer shall be liable for rejection. Information shall be separately given for individual type of equipment offered.

i. Structure of the organization.

ii. The duties and responsibilities assigned to staff for ensuring quality of work.

iii. The system of purchasing, taking delivery and verification of materials.

iv. The system for ensuring quality of workmanship.

v. The quality assurance arrangements shall conform to the relevant requirement of ISO-9001 or ISO-9002 as applicable.

vi. Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in the presence of suppliers representative, copies of test certificates.

vii. List of manufacturing facilities available.

viii. Level of automation achieved and list of areas where manual processing exists.

ix. Manufacturing process shall be fully automatic with dust proof/air conditioned working atmosphere.

x. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

xi. List of testing equipment available with the bidder for final testing of equipment specified and test plant limitation, if any vis-à-vis the type. Special acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in the "Schedule of Deviations" from the specified test requirements.

b) The Successful bidder shall within 30 days of placement of order, submit the following information to the Owner.

i. List of raw material as well as bought out accessories and the names of sub-suppliers selected from those furnished along with the offer.

ii. Type test certificates of the raw material and bought out accessories if required by the Owner.

iii. Quality Assurance Plan (QAP) with holds points for owner inspection. QAP and owners hold points shall be discussed between the Owner and successful bidder before the QAP is finalised.

iv. The successful bidder shall submit the routine test certificates of bought out accessories and central excise passes for raw material at the time of routine testing if required by the owner and ensure that the quality assurance requirements of specifications are followed by the sub-contractor.

c) The Quality Assurance Programme shall give a description of the Quality System and Quality Plans with the following details:

i. Quality System

- The Structure of the organization.
- The duties and responsibilities assigned to staff for ensuring quality of work.
- The system of purchasing, taking delivery and verification of materials.
- The system of ensuring quality workmanship.
- The system of control of documentation.
- The system of retention of records.
- The arrangement of successful bidder internal auditing.
- A list of administrative and work procedures required to achieve successful bidder quality requirements. These procedures shall be made readily available to the Owner for inspection on request.

ii. Quality Plans:

- An outline of the proposed work and programme sequence.
- The structure of contractor's organizations for the contract.
- The duties and responsibilities ensuring quality of work.
- Hold and notification points.
- Submission of engineering documents required by this specification.
- The Inspection of the materials and components on request.
- Reference to successful bidder work procedures appropriate to each activity.
- Inspection during fabrication/construction.
- Final inspection and test.
- The Owner reserves the right to seek documentary proof of the source of material (insulation, outer sheath, and other cable components) and to cross check with the supplier.

12.00.00 INSPECTION:

12.01.00 Inspection may be carried out by the owner at any stage of manufacture. The successful bidder shall grant free access to the owner's representative at a reasonable time when the work is in progress. Inspection and acceptance of any equipment under this specification by the owner shall not relieve the bidder of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective. The supplier shall keep the owner informed in advance about the manufacturing program so that arrangement can be made for inspection.

The Owner will depute Three Engineers from KPTCL and BMRCL for inspecting the equipments / materials. The Visa, to and fro travel expenses from the place of working of officials deputed for inspection, boarding charges, lodging charges and other incidental expenses of the inspecting Engineers for inspections to be carried out outside the c

ountry are to be borne by the Contractor.

12.02.00 The owner reserves the right to insist for witnessing the acceptance/ routine testing of the bought out items.

12.03.00 No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested in presence of the owner's representative and cleared for dispatch.

12.04.00 The supplier shall give 30days advance intimation to enable the owner to depute his representative for witnessing type tests, acceptance and routine tests.

13.00.00 PACKING AND MARKING:

13.01.00 DELIVERY LENGTH OF CABLE:

It is important to note that the correct delivery length on each drum and the total no. of drum to be delivered shall be ascertained by the contractor before manufacture, by cable route survey and approval of the owner / purchaser.

Note:

a) Economic drum length shall be got approved from the owner during the survey of route by the successful bidder and drum diameter shall not be less than 20 D.

b) Each cable end shall be hermetically sealed by means of metal cups using wiping lead so as to protect the cable from moisture penetration during transit, storage and laying. Pulling tension shall be furnished by the successful bidder.

c) The vendor shall be responsible for any damage to the cables during transit due to cable or reels not having been properly fastened, packed and secured.

d) Two Nos. of swivels of suitable capacity shall be supplied along with the first batch of cables free of cost.

e) The maximum weight of cable along with drum to be furnished by the successful bidder before execution of works.

13.02.00 The cable should be wound on non-returnable strong steel drums. The dimensional drawings of steel drums shall be furnished with the bid. The drum shall be provided with circumferential lagging of strong wooden planks. The end

of the cable shall be sealed with good quality heat shrink sealing caps. The required additional sealing caps of sufficient quantity shall be supplied for use of testing during laying and jointing at site and to seal spare lengths of cable.

The packing should be able to withstand the rigorous of transport.

The following information in bold letters in English shall be painted on the flanges.

(i) Name & Address of the manufacturer, Trade name/Trade mark/Brand.

(ii) Size of cable (Cross section) rated voltage, standard, insulation, cable code, drum No., year of manufacture.

(iii) Length of cables (Meters)

(iv) Direction of rolling

(v) Net weight (in Kgs)

(vi) Gross weight (in Kgs)

(vii)Owners purchase order reference.

Handling & Storage:

All accessories & spares shall have a minimum shelf life of 10 years. Detailed instructions for storing accessories & all equipments which are supplied by the vendor shall be indicated.

14.00.00 DESPATCHES:

No dispatches shall be made without approval by the owner to the test certificates. All dispatches shall be made to the consignees intimated by the owner.

14.00.01 CABLE LENGTHS:

The correct total quantity, the no. of drums, the length of the cable on each drum shall be ascertained by the contractor from the owner, at the time of manufacture. This is in view of any change, in the already finalized route plan, profile, which may arise due to any unforeseen circumstances, between the period of placing the order and commencement of manufacture.

15.00.00 DELIVERY AT STORES/SITE STORES

The stores/site is located at Bangalore. All regulations governing the transport of goods by various modes of transport shall be observed by the contractor.

It will be the sole responsibility of the contractor to deliver the goods safely at the owners stores/site stores, including, handling, unloading etc.,

16.00.00 INSTALLATION:

16.01.00 SURVEY – ROUTE PLAN:

16.01.01 The bidders are requested to fully inform and acquaint themselves on the local site conditions, which have a direct bearing on the cost estimates and execution of the work.

The tentative cable route plan is furnished to the bidder, indicating the roads, position of road crossings, railway crossing & drainage crossings etc., in the drawing enclosed with the bidding document. In case of variation during actual survey or any deviation in quantity payment would be made as per quantities executed as per actuals.

The contractor shall make a detailed survey of the cable route, by excavating the trail holes as warranted by the local conditions and prepare necessary drawings. All relevant data, required shall be properly recorded and preserved for future use and to decide on requirements of :

- Cable delivery length per drum
- Proposed cable sections
- Location of joint bay positions
- Type and quantity of joints required
- Final cable route plans
- Design of cable ducts/trench for road crossings, drainage crossings etc.,
- Identify location for bonding

The survey data on the cable route should also include recording of the information required for cable design, such as

- Type of soil along the cable route, soil resistivity.
- Soil thermal resistivity, PH value
- Sub soil water locations and other relevant information in designing the ducts and pipes for cable.

16.01.02 LOCATION OF JOINT BAYS:

The location of the joint bays should be carefully decided to avoid, traffic hazards, collection of subsoil water and any possibility of flooding due to storm waters. The joint bays located should be easily accessible for inspection and tests.

16.01.03 CABLE LENGTH, SECTIONS:

The maximum and minimum delivery lengths of cable that can be supplied shall be furnished by the bidder in the tender.

The successful bidder shall carryout a final route survey, fix joint bay locations and finalize the sections and delivery lengths.

A tolerance of +1% may be assumed while finalizing the actual cable length. The work on installation and laying of cables will be taken up by the contractor only on approval of the route plans by the purchaser.

16.01.04 CABLE INSTALLATION RECORDS:

The route plan records/drawings and the final route plan drawings after installation and commissioning should be furnished to the purchaser. Three transparencies and nine Xerox each 1) of route plan, and 2) Final route map after installation shall be furnished. Soft copy of the same to be furnished in CDs.

16.01.05 The preparation of cable route plans and cable records, relevant sections of Indian standards publication IS: 1255, "Code of practice for installation and maintenance of paper insulated power cable" or any other appropriate international standard may be referred for guidance.

16.01.06 SOIL THERMAL RESISTIVITY / SOIL RESISTIVITY :

The successful bidder shall investigate the soil characteristics along the cable route, at the required laying depths to evaluate the parameters, governing the cable design.

The thermal resistivity tests should be carried out at every 200M interval along the cable route. At each location the T.R. tests are taken at three different depths and two soil samples are taken for further laboratory analysis.

The laboratory analysis of the soil samples collected from the site should be conducted in detail, including soil identification, moisture content, density, organic content, critical moisture content of each soil type encountered along the route and arrive at the T.R values of the native soil.

These tests should be conducted by using reliable measuring instruments with fully automated thermal property analyzer and thermal probes, through reputed agencies, like GEOTHERM, CPRI, Technical Institutions etc., KPTCL/BMRCL will depute its Engineer to witness these tests.

The generally assumed value of the soil thermal resistivity is 120 to 150 deg. C cm/w.

The PURCHASER anticipates the presence of soil strata at a few locations along cable routes with a soil thermal resistivity of more than 150°C Cm/w.

However, the successful BIDDER shall be responsible to ensure that no derating of the cable will take place on account of variation in soil thermal characteristics. In consultation with the OWNER, the BIDDER shall analyse and indicate the appropriate backfill (STB) recommended. Bidder will have to

design the trench optimally to take care of local site conditions. The maximum permissible soil thermal resistivity shall be limit to 120°C Cm/w in fully dried condition out of the locally available materials to achieve maximum current capacity for the cable section used. BIDDER shall ensure that no derating of the cable takes place on account of soil/backfill thermal characteristics and that proper backfill is used.

In conformity with the above requirement, the BIDDER shall determine and advise on the following:

- Optimum design of trench to take care of local hot spots and methods to improve effective Thermal resistivity value.
- The type of graded sand to be utilised by sieve analysis as one of the components of the STB backfill to obtain tight fit soil.
- The optimum Kaolinitic clay content in the soil to make it less porous and of high specific surface area for optimum moisture retentivity suitable for areas prone to moisture migration on account of low water table.
- The ratio of the weak mix of sand, cement and flyash, cement and water (by volume/weight), the type of cement of adequate compression strength and mixing procedure of the three constituents to ensure the best thermal resistivity value of the STB in fully dried condition and to ensure low breaking strength of the STB for ease of breaking in case of fault repairs and laying of second circuit, if required.
- The ratio of the weak mix of sand, cement and flyash, cement and water and other suitable material like Fullbent etc., to be utilised in joint bays to facilitate breaking/removal of cement bound sand (weak mix) in future, if necessary.
- Compacting procedures indicating the method and type of compaction for obtaining high density, using vibration dampers, for granular soils and adequate moisture content for lubrication purposes of clay soils.
- The temperature rise above the ground temperature of 30°C corresponding to the area of the isotherm required to ensure no derating in the current carrying capacity of the cables. BIDDER shall ensure that no derating of the cable takes place on account of soil thermal characteristics and that proper backfill is used to ensure maximum/optimum current carrying capacity from the cable used.
- The suggested stabilized thermal backfill i.e., STB is of the following composition (cement 2.5% by weight, flash 11% by weight and graded sand

86.5% by weight). BIDDER should advise on the use of any other locally available binder and the amount to be used with sand and cement to give a soil thermal resistivity of less than 120^0 cm/w in fully dried condition of the STB. Bidder shall be responsible for ensuring the best "effective" thermal resistivity.

Subsequent to completion of backfilling, in-situ measurements of soil thermal resistivity, dry cured density, void ratio, moisture and clay contents of the soil shall be carried out by the BIDDER along the cable routes at regular intervals mutually agreeable to the BIDDER and PURCHAER, using his own instruments as a quality check on the backfill employed and method of back-filling and detailed report shall be submitted by BIDDER.

However, the contractor shall carry out the required investigation and tests evaluate and determine the soil resistivity and soil thermal resistivity along the cable route, at cable laying depth, to the satisfaction of the purchaser.

16.01.07 THERMAL BACKFILLS:

For the purpose of price evaluation, the bidders shall quote the unit rate (Rs./meter run) for providing the thermal backfill of stable T.R. value of 120 deg. C cm/w. The necessary technical data on the bidders proposal for thermal backfill shall be furnished along with the bid.

The contractor shall design, specify, supply formulate, test and lay a suitable backfill, only if the owner desires and with the prior approval of the owner, if found necessary after the receipt of the route thermal survey report for thermal characteristics of the soil.

16.02.00 LAYING AND INSTALLATION OF CABLE:

16.02.01 GENERAL

The successful bidder shall carry out all activities connected with the laying and installation of the power cables and completion of the work for which the project is intended and to the full satisfaction of the owner.

Notwithstanding subsequent changes/alterations in route/ design, the bidders, shall quote in their bid proposals for carrying out the cable installation work as per the specifications of the owner, which will be considered for bid evaluation. However, alternate installation arrangements offered from the bidders, with clear justification for these alternatives, will be considered by the owner, if they prove to be of a better and economical design and also the quoted bid value is the lowest.

16.02.02 SCOPE :

This scope covers the proposed method of cable laying, in ground i.e. directly buried in ground, laying inducts, pipes and in air. The excavation and construction of R.C.C., stone masonry, brick masonry, ducts, laying of pipes for installing cable and also for the construction of jointing bays as per requirement of the field conditions.

The scope also includes supply of all requisite materials, labour, tools and plant like sand, brick, stones, steel, cement aggregate for reinforcement, pipes, joint and route markers and all other consumable required for the completion of the work.

The bidder shall insure for materials. The bidder shall handle, load, transport, unload and store all materials at site and arrange for security till commissioning and handing over to the owner / Purchaser.

16.02.03 DRAWINGS:

The bidder shall prepare the drawings for applicable field conditions of cable installation, like cables directly buried, in ducts, in road crossings, on drainage crossings, cable jointing bays, manholes if any, and furnish 6 copies of each to the owner for approval.

All works are to be executed only after due approval of the competent authority and under the supervision of Engineer In charge.

16.02.04 SPECIFICATIONS :

These specifications are intended for general description of quality, of materials and workmanship of finished work.

They are not intended to cover the minute details. The work shall be executed in accordance with the best modern practices, Indian standards (I.S) and other relevant codes.

The specifications, referred to above are I.S. standards relevant Civil Engineering Works and cable laying works.

The specifications shall be read in conjunction with the other parts of the bid documents.

The purchaser's decision shall be final on any issue in respect of installation.

16.02.05 INSTALLATION OF U.G. CABLES :

Installation : The cables shall be laid generally for a major length of the route in "directly buried in ground" method in Trefoil touching formation to form 66 KV 3- single core single/double circuit system. However, as per requirement of the field, the cables shall also have to be laid.

- In ducts.

- In HDPE pipes in trefoil/horizontal formation (pipes to be filled with sand/suitable material after cabling).
- In Air at terminations.
- At varying depths due to obstructions.
- As per approved drawings.
- In HDPE pipes for railway crossing.

16.02.06 INSPECTION STORAGE AND HANDLING:

The contractor should take all necessary precautions for inspection of cables on receipt and for the proper handling and storage. The contractor shall have his own arrangement for transporting the cables, materials, equipment to site and back to store.

The cables shall be stored on hard packed surfaces and protected from harmful weather conditions.

The cables drums shall be mounted and transported on only approved type cable drum conveyors. The cable should not be bent beyond permissible limits of the bending radius while laying and jointing.

16.02.07 STATUTORY CLEARANCES:

The installation of cables shall be as per established code of practice and fulfill the requirements of statutes. Obtaining all statutory clearances from other utility services, like telephones, water supply, power supply, Railways, National highways, Bruhat Bangalore Mahanagara palike and other local administrative authorities for road cutting etc., for laying the cable will be the responsibility of the successful bidder.

All necessary approvals of the concerned authorities are to be obtained before execution of the works by the successful bidder and necessary assistance will be rendered by the owner.

The civic / national highways / traffic / defense authorities / Railway / Telephones/Water supply/Power supply/Mahanagara Palike and other local administrative authorities etc., charge as per their standard schedules / rates which will be intimated by them from time to time for grant of permission/approvals for trenching/laying pipes/laying cables etc., shall be paid by the successful bidder. These charges are reimbursable by the owner as per actual, on production of valid vouchers.

Restoration of the surface to its original condition as per the requirements of the concerned authorities is also included in the scope of the work. (Necessary specification and drawing of Bruhat Bangalore Mahanagara Palike is included in the Annexure- A)

The statutory charges towards "supervision charges" and "Road cutting permission fee" are reimbursable by the owner as per actual on production of valid vouchers towards grant of permission/approval for Road cutting only, by BBMP.

Presently BBMP is collecting 10% each of the Total restoration cost towards supervision charges and Road cutting permission fee respectively based on the estimate prepared by BBMP adopting KPWD SR and National High way SR rates.

Apart from the above statutory charges, BBMP also collects Caution deposit in advance (Refundable). Presently BBMP is collecting 25% of the Total restoration cost towards Caution deposit based on the estimate prepared by BBMP adopting KPWD SR and National High way SR rates. BBMP would refund this deposit to KPTCL/ BMRCL subject to satisfactory restoration as per specification prescribed. This caution deposit is to be deposited by the successful bidder to BBMP. KPTCL/BMRCL would return the deposit to the contractor after receipt of the deposit from BBMP duly deducting any amount recovered by BBMP for the rectification of any defect towards restoration work carried out by the contractor.

16.02.08 TRENCHING:

The cable trench work involves earth excavation for cable trench, backfilling and removal of excess earth from site. The work site shall be left as clean as possible after completion of the work.

The trench shall be excavated using manual and mechanical modes as per field conditions. Most main roads are of asphalt surface and some of the roads with cement concrete surface.

An air compressor with pneumatic drill or equivalent mechanical tool will be essential if the road crossings and railway crossings involving horizontal drilling i.e., Trench-less cutting wherever necessary.

Where paved footpaths are encountered, the pavement slabs shall be properly stored and reinstated. Identification markers of other services shall be properly stored and restored.

The sides of the excavated trenches, shall wherever required, be well shored up with timber and sheeting.

Suitable wooden barriers should be erected between the cable trench and pedestrian/motor way /railway to prevent accidents. The barrier could be made out of Jungle wood/Deal wood planks.

These could be portable types of size 1.5 M (long) by 1.2 M (height). These barrier should be painted with yellow and black or red and white coloured cross

stripes. Warning and caution boards should be consciously displayed. Red lights as warning signal should be placed along the trench during the nights and any other requirements as per the traffic authorities.

The excavated material shall be properly stored to avoid obstruction to public and traffic movement. The cable shall be laid immediately after formation of the trenches.

The bottom of the excavated trench should be leveled flat and free from any object which would damage the cables. Any gradient encountered shall be gradual.

16.02.09 CABLE HANDLING

The inspection of cable on receipt, handling of cables, paying out, flaking, cushioning with sand or sieved compacted native soil, backfilling, reinstatement of road surfaces, providing and fixing joint markers, route indicators, preparation of joint holes, sump holes and all necessary precautions that are required shall be carefully planned and in general conform to IS 1255 or its equivalent.

16.02.10 DAMAGE TO PROPERTY:

The contractor shall take all precautions while excavation of trench, trial pits etc., to protect the public and private properties and to avoid accidental damage. Any damage so caused shall be immediately repaired and brought to the notice of the concerned and to the owner.

The contractor shall bear all responsibilities and liabilities and shall bear all costs of the damages so caused by him or by his workman or agents.

16.02.11 CABLE OVER BRIDGES:

Wherever the cable route crosses the bridges, the cables shall be laid in ducts. In existing ducts by removing and replacing the R.C.C. covers and properly back filled.

16.02.12 CABLE CROSSING OPEN DRAINS WITH LONG SPAN:

1. Wherever the cable route has to cross an open drain, with a long span, the cable shall be laid in suitable size ducts or pipes, suitably jointed with collars. The entire duct system shall be designed as per civil engineering practice and shall be got approved by the concerned authorities and owner.
2. At places where the cables cross private roads, gates of residential houses or buildings, the cables shall be laid in **HDPE Pipes**.

16.02.13 CABLE ROUTE MARKERS/CABLE JOINT MARKERS

Permanent means of indicating the position of joints and cable route shall be fabricated supplied and erected as per drawings approved by owner.

Markers provided shall be as per the field requirement. If the route passes through open fields, markers should be conspicuously visible and above ground surface.

The marker should incorporate the relevant information: The name of the owner, voltage, circuit and distance of cable from the marker.

16.02.14 LAYING OF POWER CABLES:

The 66KV (E), single-phase cables shall be laid in Trefoil formation, forming one/two circuits, laid in the same trench/duct normally buried directly in ground complying with all applicable standards as per drawings approved by the owner.

The cables shall be laid wherever required in HDPE pipes of ISI approved quality.

When cables are laid in RCC hume pipes, the following points shall be taken care of:

If one cable (single phase) is laid through the cement concrete pipe, the CC pipe should have no reinforcement of steel rods.

The cable shall occupy 30-40% of the area of the cross section of pipe.

The CC pipes shall be backfilled by sand after installing the cable.

The cables shall be protected by covering with a pre cast RCC slab of approved design and marking throughout the length of the route.

16.02.15 IDENTIFICATION:

An identification marker/Tag of lead of size 50 mm x 25 mm x 2mm shall be provided at 1 meter intervals throughout the route length of the cable and fastened with a suitable nylon string. The marker shall be embossed/punched on both sides with the letters KPTCL, 66KV, CKT-1 and KPTCL, 66KV CKT-2 respectively, in case of double circuits phase identification by coloured PVC tape shall be at 1 M interval. Alternatively plastic tags may be used. These tags should also be fixed, at the cable inlet and outlets of a duct, tunnel, manhole and joint bays.

16.02.16 WARNING TAPE :

A pre-warning, red colour plastic/PVC tape, 150 mm wide 100 microns thick, shall be laid at specified depth, throughout the cable route. The tape shall carry the legend printed in black continuously as under **CAUTION: KPTCL/BMRCL, 66000V 630sqmm EHV UG CABLES.**

16.02.17 PAVING OUT THE CABLE

The excavated cable trench shall be drained of all water and the bed surface shall be smooth, uniform and fairly hard before paving out the cable. The cable shall be rolled in the trench on cable rollers, spaced out at uniform intervals. The paving out process must be smooth and steady without subjecting the cable to abnormal tension. For this power winch, power roller – both straight and angle roller, may be used. The cable on being paved out shall be smoothly and evenly transferred to the ground after providing the cushion. The cables

shall never be dropped. All snake bends shall straightened. Suitable size cable stocking pulling eye shall be used for pulling the cable. While pulling the cable by winches or machines, the tension loading shall be by tension indicator and shall not exceed the permissible value for the cable. The cable laying shall be performed continuously at a speed not exceeding 600 to 1000 mtrs. Per hour. The cable end seals shall be checked after laying and if found damaged shall immediately be replaced, sufficient number of heat shrinkable cable end sealing caps shall be stocked at site stores for testing and jointing work. The integrity of the outer sheath shall be checked after the cable is laid in position. Bell mouth shall be used whenever the cables are drawn inside HDPE pipe, duct.

16.02.18 FLAKING:

The cables shall be flaked and left with slight extra lengths at jointing bays for expansion and flexibility.

16.02.19 SAND CUSHION:

The sand cushion for the cables shall be provided as per the drawings. Sand covering shall be done by hand and in such a manner as to provide complete envelope for the cables and a good bedding for protection covers.

16.02.20 THERMAL BACKFILL:

Based on the evaluation of soil thermal resistivity along the cable route and after approval from the owner the contractor shall design, specify, supply, lay and monitor the installation of thermal backfill surrounding the cables.

16.02.21 IMMEDIATE ENVELOPE TO CABLE:

The option on the use of the material which immediately envelops the cable viz., thermal backfill or sand or sieved native soil rests with the owner. The contractor shall seek prior approval on the use of the envelop material from the owner before execution of the works.

16.02.22 PREVENTION OF DAMAGE DUE TO SHARP EDGES:

After the cables have been laid in the trench and until the cables are covered with protective covering, no sharp metal tool shall be used in the trench or placed in such a position that may fall into the trench.

Straight and curved (angle) rollers used shall have no sharp projecting parts liable to damage the cable.

While pulling through pipes and ducts, the cable shall be protected to avoid damage due to sharp edges. Bell mouth shall be used whenever the cables are drawn inside HDPE pipe, duct.

The cables shall never be bent, beyond the specified bending radius.

16.02.23 ROAD CROSSINGS :

The road cutting for cable trench, whether cement concrete, asphalt or macadam road surface shall be taken after obtaining approval for cutting from the civic authorities, traffic police, telephone authorities and work should be planned to be completed in the shortest possible time. Where necessary the work shall be planned during night or light traffic periods.

In the excavated trench across the road, the cables shall be laid in HDPE pipes. The pipes shall be embedded in RMC 1:2:4 back filled with sand/earth as required and directed and surface shall be redone in the shortest possible time, as per the requirement of the Civic authorities.

16.02.24 FOOTPATH CUTTING:

The slabs, curbstones on the roads shall be removed and reinstated without damage.

16.02.25 REINSTATEMENT:

After the cables and pipes have been laid and before the trench is backfilled all joints and cable positions should be carefully plotted and preserved till such time the cable is energized and taken over by the Engineer. The cables shall be provided with sand cushion as per the approved drawing. The protective covers shall then be provided. The trench shall be back filled with riddled/sieved river sand and reinstatement work as per the requirements/procedure prescribed by BBMP in force shall be done in the shortest possible time.

It is advisable to leave a crown of earth not less than 50 mm and not more than 100 mm in the centre and tapering towards the sides of the trench.

The temporary reinstatement of roadways should be inspected at regular intervals, more frequently in rainy season and immediately after overnight rain for checking settlement and if required, then temporary reinstatement should be done.

After the subsidence has ceased the trench may be permanently reinstated and the surface restored to the best possible condition.

In case of the road surface being cement concrete, asphalt or tarred macadam, resurfacing shall be done as per the requirements of the civic authorities.

16.02.26 JOINTING BAYS:

The bidder shall identify the location of the joint bays after carrying out detailed survey of the cable route and excavation of the trail pits. The delivery lengths of the cables shall match the location.

The joint bays shall be of sufficient size to accommodate jointing of cables and constructed with RCC M20 Grade and Fe 415 Steel. It shall consist of RCC raft

laid over PCC 1:4:8, RCC Retaining walls/Side walls and RCC cover slab with an inspection chamber. All exposed faces of raft, slab and side walls shall be plastered with 12mm thick Cement Mortar 1:4. At the bottom in a corner, a sump pit shall be made for bailing out water.

After completion of all the works, viz., construction of jointing bay, laying of cables, testing of cables/jointing etc, the jointing bay shall be backfilled with riddled sand

The contractor shall submit an economical design and drawing of joint bay for approval of the owner.

All works shall be carried out in presence and supervision of the engineer.

16.02.27 **Railway Crossing**:

The earth shall be excavated using an air compressor with pneumatic drill or equivalent mechanical tool for laying pipes for crossing of railway track after obtaining prior approval of railway authority. The work shall be planned to be completed within shortest possible time. The work shall be carried out as per the standard practice suggested by railway authorities.

16.02.28 TOOLS AND PLANT:

The successful bidder shall have all necessary tools, plant and equipment to carry out the survey and cable installation work.

The bidders are instructed to give all the details of equipment at their disposal, to carry out the work successfully and speedily.

16.03.00 JOINTING AND TERMINATING:

16.03.01 JOINTING OF CABLES:

GENERAL:

The cable jointing personnel and his crew shall have good experience in the type of joints and terminations that are used. The jointing work shall commence as soon as two or three lengths of cables have been laid. All care should be taken to protect the factory-plumbed caps/seals on the cable ends and the cable end shall be sealed whenever the end is exposed for tests.

Jointing of cables in carriageways, driveways under costly pavings, under concrete or asphalt surfaces and in proximity to telephone cables, and water mains should be avoided whenever possible.

Sufficient over lap of cables shall be allowed for making the joints.

The joint bay should be of sufficient dimensions to allow the jointers to work with as much freedom of movement and comfort as possible. Sufficient space should be kept below the cable to be jointed.

The joints of different phases shall be staggered in the jointing bay.

The cable jointing work should be necessarily got done only through well trained professional jointers.

Jointing work details

i) Uncoiling, cleaning, straightening and trimming of 220kV/110kV/66kV cable as required for jointing.
ii) Checking the cable inside the joint bay before cutting the cable, for any accidental damages due to re-excavation.
iii) Providing the joint tent, tools etc., at the site by the vendor.
iv) Erection of joint tent, (joint tests should be of metallic housing.
v) Electrification of the joint bay, arranging and fixing of air conditioners and maintaining them for the entire period of jointing (temperature inside the joint tents should be maintained below 25 deg C.)
vi) Transporting the required quantity of jointing kits from stores to site (Including link boxes)
vii) Dismantling the wiring, air conditioner etc.
viii) Dismantling the joint tent.
ix) Devolution of cable cut bits to departmental stores including transport
x) Providing security guards for joint bay.
Cost of power for the entire period of jointing.
Providing 2 Nos. 2 HP Diesel Dewatering pumps.

16.03.02 SUMPHOLES:

When jointing cables in water logged ground or under unforeseen rainy conditions, a sumphole should be made at one end of the joint bay, in such a position so that the accumulated water can be pumped or bailed out by buckets without causing interference to the jointing operation.

16.03.03 TENTS/COVERS

Erection of Joint tent (Joint tent shall be of metallic housing) Electrification of Joint bay, arranging and Fixing of Air conditioners and maintaining them for entire period of jointing (Temperature of Joint tent should be maintained below 25 deg. C)

Providing sheath protection for earthing wherever necessary all accessories and spares required shall be of satisfactory operation for 10 years and furnish the details of maintenance.

16.03.04 PRECAUTIONS BEFORE MAKING A JOINT:

The cable end seals should not be opened until all necessary precautions have been taken to prevent circumstances arising out of rainy/inclement weather conditions, which might become uncontrollable.

If the cable end seals or cable ends are found to have suffered damages the cables should not be jointed, without tests and rectification.

16.03.04A **PERT CHART/ACTIVITY CHART:**

Indicating time schedule for supply of cable and accessories and supervision of cable laying, testing and commissioning shall be furnished by successful

vendor in consultation with the purchaser and should got approved along with drum length approval. The schedule should be kept up by the vendor. Any delay in completing the work will attract penalty.

16.03.05 MEASUREMENT OF INSULATION RESISTANCE:

Before jointing, the insulation resistance of both sections of cables shall be checked.

Before laying cable in the ground, the insulation resistance of each section shall be measured.

16.03.06 IDENTIFICATION :

The identification of each phase, shall be clearly and properly noted. The cables shall be jointed as per the approved design. Each cable shall have identification for phase and circuit at joint bays.

16.03.07 MAKING A JOINT:

Comprehensive jointing instructions should be obtained from the manufacturer of jointing kits and meticulously followed.

The materials used in the joints like ferrules, screen/sheath continuity bonds, lugs, etc., shall be of good quality and conform to standards.

The jointing tools shall be appropriate and as per the requirement of jointing EHV XLPE cables.

16.03.08 CABLE TERMINATIONS:

The cable terminations used are outdoor type:

The preparation of the cable end for installing the terminations and the precautions to be taken before fixing the terminations shall be followed as in the case of the cable jointing procedures.

The instructions furnished by the termination manufacturer shall be strictly followed.

At cable terminating end, the following provisions for supply and erections are to be included.

I. At sufficient length of spare cable shall be left in the ground, for future needs.
II. The rise of the cable, immediately from the ground shall be enclosed in 150 mm dia PVC/PE pipe to protect against direct exposure to the sun.
III. The cable shall be properly fastened using nonmetallic clamps.
IV. Appropriate labels shall be fixed identifying the phase, circuit, voltage and date of commissioning etc., on the cable supporting structure.
V. The sealing end shall be mounted on pedestal insulators to isolate them from their supporting steel work.
VI. Protection from contact with the exposed metal work at the termination, shall be provided by resin bonded glass fiber shroud.

VII. Providing earth stations with all required materials, like leads, connectors, earthing rods/pipes etc.

ACCESSORIES

Dust and humidity free enclosures, complete will air conditioners and material handling equipment shall be used by the vendor.

All special tools including a set of jointers hand tools that are necessary to complete the joint/termination works shall be arranged by the vendor. Not necessary power supply for jointing and termination works shall be arranged by the vendor.

The cost of consumables which are essential for satisfactory erection and commissioning shall be included.

Adequate quantity of consumable shall be supplied for completing the entire cable laying and jointing works.

Termination Work details:

1) Erection of termination structure.
2) Removal of cable from the trench, rerouting, cleaning straightening and trimming if necessary, checking the exposed cable before cutting the cable for any accidental damages due to re-excavation.
3) Providing of scaffolding pipes, clamps, wooden planks and tools for erection of termination.
4) Erection of scaffolding pipes/ providing crane for lifting 220kV/110kV/66kV cable and termination.
5) Lifting the cable up the terminal structure and positioning.
6) Transporting the termination kit from departmental stores (including link boxes)
7) Dismantling scaffolding work.
8) Transporting the above item back.
9) Devolution of cable cut bit to departmental stores including transport.
10) Provision of security guard for the cable end/ termination.
11) Providing fire retardant paint for exposed portion of the cable and other related works.
12) Cost of power for the entire period of work.

16.03.09 BONDING OF SCREEN/SHEATH:

The type of bonding i.e., single end bonding/both end bonding/cross bonding as recommended by the successful bidder, shall be adopted.

For one/both end bonding:

The screens at one end / both ends, shall be brought out and solidly bonded/or through SVL to the earth station through disconnecting type link boxes.

The link boxes, single phase outdoor type with SVL at receiving end (with bypass arrangement for SVL) and without SVL at sending end shall be provided.

All accessories and consumable used in the termination should be of good quality and compatible with the cable.

For cross bonding:

Shall be executed as recommended in Clause No.7.04.03.

16.03.10 CONNECTION OF RADIAL WATER BARRIER AND CABLE SCREEN

If the metallic radial water barrier is insulated from the metallic wire screen a connection suitable to carry the currents occurring during operation must be installed between metallic radial water barrier of the cable and metallic wire screen in joints and sealing ends.

16.03.11 ERECTION OF CABLE TERMINATING STRUCTURE :

The terminating structure should be designed as per the requirement of the cable end sealing, offered by the bidder.

The mounting structure shall have good cement concrete foundation as per civil engineering norms. If the termination is to be mounted on the transmission tower, necessary modifications be made.

After fixing the end termination, the cable shall be fixed to the support, with nonmagnetic material clamps to the required height securely. The drawings of station structure and equipment for connection of cable will be furnished by the owner.

16.03.12 Surplus Cable

The wastage of cable beyond practically required permissible limits should be avoided.

For any valid reason if there is a surplus cable, it shall be returned to the owner's store.

Approved good quality sealing caps, heat shrinkable type of the correct size, shall be supplied for spare cut lengths of cable exceeding 100 M length, to enable them to be properly stored for future maintenance purposes. The successful bidder shall be responsible for the immediate sealing of such cut lengths and the cost of the sealing end etc., thereof shall be deemed to have been included in the contract price.

The successful bidder shall clean the completed cable route and shall remove all surplus and waste materials, empty cable reels etc., preferably the same day but not later than the next day after the particular work is completed.

16.03.13 MAINTENANCE OF SITE CONDITIONS

The contractor shall clean the completed cable route and shall remove all surplus and waste materials, empty cable reels etc., preferably the same day but not later than the next day after the particular work is completed.

16.04.00 CIVIL AND STRUCTURAL WORKS:

GENERAL: This specification deals in brief with the civil and structural works for cable laying.

a) The scope of civil works include earth excavation and cable laying, removal of excavated earth, design, supply and provide plain and reinforced cement concrete for foundations of equipment, support structures. Back filling, dewatering of trenches. Design, supply and providing cable jointing bays. The design of cable duct/pipe ducts for crossing drains, roads, etc., shall be suitably done and rates quoted, making provision for complete supplies and erection as per relevant schedules. It includes all connected civil works.

b) Design, fabrication and supply of galvanized steel structures for cable end terminations, mounting of earthing link boxes.

c) Supply of all consumables and sundry materials not included in the specifications in detail but are necessary to meet the intent of the project.

16.04.01 CODES AND STANDARDS :

Unless otherwise stated, latest editions of the following standards are applicable.

IS : 1255	:	Installation and maintenance of power Cable.
IS : 5820	:	Specification for pre-cast concrete cable cover.
IS : 209	:	Quality of zinc for galvanizing.
IS : 226	:	Structural steel.
IS : 456	:	Plain and reinforced cement concrete.
IS : 800	:	Use of structural steel in general building construction.
IS : 2016	:	Plain washers
IS : 2633	:	Zinc coating on galvanized steel.
IS : 3063	:	Spring washers.
IS : 5358	:	Hot Dip Galvanised coating on fasteners.
IS : 6639	:	Hexagonal bolts for steel structures.

Any other equivalent International/ National standard.

16.04.02 EXCAVATION :

The specification covers excavation for cable trenches, ducts, structural foundations, jointing bays.

The contractor shall control the grading in the vicinity of all excavations so that the surface of the ground will be properly sloped or diked to prevent surface water from running into the excavated area during construction.

The excavation shall includ the removal of all materials required to execute the work properly and shall be made with sufficient clearance to permit the placing, inspection and setting of forms and completion of all works for which the excavation was done.

The sides and bottoms of excavation shall be cut sharp and true. Under cutting shall not be permitted. Earth sides of excavation shall not be used in lieu of form work for replacement of concrete unless authorized by the Engineer where the limitations of space for large excavation necessitates such decision.

16.04.03 QUANTITIES :

The bidder shall indicate the ceiling volumes/quantities for excavation and RCC works and steel structure works, wherever specifically indicated.

16.04.04 The bidder shall quote unit rates for the items of works. He shall also quote the total price for each of the works.

16.04.05 The quoted price shall also include supply of all material, transportation charges, taxes, duties, octoroi, Royalty and toll, labour, construction plant and equipment and fixtures, fittings and all temporary and permanent works necessary for satisfactory completion in all respects.

16.04.06 The measurements of various civil works shall be jointly recorded by the contractor and the Engineer-in-charge and duly certified.

16.04.07 When machines are used for excavation the last 300mm before reaching the required level shall be excavated by hand or by such equipment that will leave the soil at required final level in its natural condition.

16.04.08 The bottom of the excavation shall be trimmed to the required level and when carried below such level by error, shall be brought to level, by filling with lean concrete of 1:4:8 mix, at contractors cost.

16.04.09 If the successful bidder is directed by the Engineer-in-charge of the owner to excavate to a lower level than that indicated on the drawing, such additional excavation shall be paid as per clause 24.2 of GCC.

The bidder is bound to carry out any Non-tendered items of work required for completion of the task. For such items payment shall be made as per clause 24.2 of GCC.

16.04.10 The contractor shall be responsible for his estimates, assumptions and conclusions regarding the nature of the materials to be excavated and difficulty of making and maintaining of required excavations and performing the work required as shown on the drawing and in accordance with these specifications. Cofferdams, sheeting, shoring, bracing, draining, dewatering etc., shall be furnished and installed as required and the cost thereof shall be included in unit rate quoted for the item of excavation. The contractor shall be held responsible for any damage to any part of the work and property caused by collapse of sides of excavation. The materials can be salvaged if it can be done with safety for the work and structure and as approved by the Engineer-in-charge.

However, no extra claim shall be entertained for material not salvaged or any other damage to contractors property as the results of the collapse. He shall not be entitled to any claim for redoing the excavation as a result of the same.

16.04.11 All excavation for installation of underground facilities shall be open cuts.

16.04.12 All foundations shall rest below virgin ground level and the minimum depth of foundation below the virgin ground level shall be at least 500mm for equipment foundations and 1000 mm for towers.

Minimum 75mm thick lean cement concrete 1:4:8 shall be provided below all underground structures, foundations trenches etc to provide a base for construction unless otherwise specified

16.04.13 When the excavation requires bracing, sheeting, shoring, strutting etc., the contractor shall submit to the Engineer-in-Charge drawings showing arrangement and details of proposed installation and shall obtain the approval from the Engineer-in-charge before proceeding with the work.

16.04.14 The contractor shall have to constantly pump out the water collected in the pits, trenches, due to rain, sub-soil, springs etc., and maintain dry working conditions at no extra cost to the owner.

16.04.15 CLASSIFICATION OF SOIL:

For purpose of excavation, the soil is classified as ordinary soil, Hard soil, Ordinary rock and Hard rock. The details of classifications are given in Annexure "TS-I".

16.04.16 MEASUREMENT OF EXCAVATION:

The measurement for the payment of earth excavation will be based on volume calculations of pit/trench. The unit of measurement shall be cubic meters. Nothing extra would be payable for slopes, shoring, strutting, etc., irrespective of whatever is provided. If directed by the Engineer-in-charge, the excavation

shall be done on the slopes from slope stability point of view at no extra cost to the owner.

16.04 .17 CARRIAGE OF EXCAVATED SOIL BEYOND A LEAD OF 50 MTRS PER LIFT OF 1.5 MTRS.

16.04.18 BY MANUAL LABOUR :

The excavated earth for disposal purpose up to 300 mtrs. shall be carried by manual labour. If directed by the Engineer-in-charge this earth shall be used for back filling purpose/ filling of low lying areas with prior approval of the concerned local bodies. The rate for disposal of earth by manual labor up to a lead of 300Mtrs shall be included in the rate for excavation items and no extra rate for the same is admissible.

16.04.19 BY MECHANICAL TRANSPORT:

The contractor shall arrange to transport the surplus earth including hard rock and soft rock left over after back filling the trench/ raising low lying areas by manual labor up to a lead of 300 mtrs, by mechanical means to the disposal point of the local bodies with all leads and lifts and as directed by the Engineer in charge.. It shall however be ensured that no soil is stacked in excavated area. Location where the soil is to be stacked/disposed shall be as directed by the Engineer-in-charge. However the contractor shall take all precautions at the site of excavation, for keeping the free flow of vehicular and human traffic and to avoid inconvenience in general.

The soil transported for disposal, shall be stacked and leveled neatly and dressed.

The rate for this item shall include loading, carriage, unloading, stacking and dressing etc., complete.

16.04.20 In no case the excavated soil shall be stacked upto the distance of 1.5 Mts. from the edge of excavation or one third the depth of excavation whichever is more.

16.04.21 LEAD AND LIFT:

The rates quoted for all items of work shall include all lifts and leads wherever applicable unless otherwise specified.

16.04.22 EXCAVATION AND MEASUREMENT IN HARD ROCK :

Blasting in hard rock shall be done as per IS: 4081 (latest edition). The hard rock excavated shall be stacked, measured and reduced by 40% for voids. Pre-measurement of rock is to be recorded when measured on section. The quantity whichever is less shall be paid.

At locations where open/un controlled blasting cannot be taken up due to site conditions, controlled blasting or removal of rock by chistling and wedging shall be resorted to. The rate for excavation of hard rock shall include its removal by all the types referred to and appropriate methods of removal shall be adopted depending on the site conditions.

16.04.23 BACKFILLING MATERIALS:

The backfilling of excavated trenches and around foundation, shall consist of one of the following materials as the Engineer-in-charge may direct in each location.

i) Selected sieved earth from excavated soil.

ii) Selected sieved earth brought from borrows area.

iii) Sand filling (sieved).

NOTE: Sieved sand shall be strictly used for all the works.

Filling shall be done after the concrete or masonry work has fully set and its curing completed.

The contractor shall fill in and around any work until it has been properly reinstated and approved by the Engineer-in-charge.

16.04.24 BACKFILLING FOR CABLE TRENCH :

Backfilling shall be done in horizontal layers of thickness not exceeding 200 mm thickness, free from pockets with careful watering where necessary for compaction. The backfill shall be riddled earth/riddled river sand free from materials likely to cause damage to the cables.

The thermal backfill surrounding the cable shall be as per the design approved by the owner.

16.04.25 MEASUREMENTS :

Payments for back filling- riddled earth/riddled sand shall be based on the volume of consolidated fill. This volume shall be derived from the difference between the volume of excavation and that of the volume of HDPE pipes/concrete/surface restoration etc.

16.04.26 CEMENT CONCRETE:

For the cement concrete, plain or reinforced for general use, requirement of concrete for nominal mix, strength and quality, pouring at all levels, form works, protection covering, finishing, add mixtures, inserts, curing etc., the provision of the latest revision of IS : 456 shall be compiled with, unless permitted otherwise by any other Indian Standard codes, shall form the part of the specification to the extent applicable within specification. The cement used

shall comply with IS : 269. The metal (Jelly) used in PCC/RCC shall be properly graded and machine mixed.

16.04.27 CURING AND PROTECTION OF CONCRETE:

All fresh concrete shall be covered with the layer of an absorbent material and kept constantly wet for a **minimum period of ten days** or more from the date of placing concrete. The immature concrete shall be protected from the damages and contamination that would impair the strength of the concrete.

16.04.28 PRE-CAST RCC ITEMS :

The concrete mix for the various types of pre-cast units shall conform to IS : 456. The aggregate shall be mixed by weight and water cement ratio shall be controlled to obtain the dense concrete and the strength required. The reinforcement shall be as per the design approved. The curing shall be carried out for the period of seven days from the date of casting and the pre-cast element shall be cured by flooding with water of minimum 25mm depth over the element for the period mentioned above.

All the pre-cast element shall be marked, appropriately as specified.

16.04.29 MASONRY WORK :

Stone masonry and brick masonry work wherever required shall be carried out by the contractor. The associated materials for masonry work like stones, bricks, sand, etc., shall be of approved quality. The construction shall comply with accepted norms and standards.

16.04.30 PLASTER :

Plastering shall be done with cement and sand mortar, 1:4 by volume with clean sand. All plaster work shall comply with IS : 1661.

Materials for plaster such as cement, sand, water shall conform to standards.

16.04.31 MOUNTING STRUCTURES:

The mounting structure includes the supports for cable end boxes, link boxes and any other structure required for the intent of the contract.

All steel sections used shall be free from all imperfections, mill scales, slag intrusions, laminations, fillings, rust, etc., that may impair their strength durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the purchaser. The structures shall be fabricated by the contractor.

16.04.32 FOUNDATION:

Foundations for mounting structures in cement concrete shall be provided as per approved drawings.

Foundation shall be of RCC type only. The design and construction of cement concrete structures shall be carried out as per IS: 456 and minimum grade of concrete shall be M-20. Higher grade of concrete than

specified above may be used at the discretion of bidder, which has to be stated at the time of bidding. If the reinforcement is required, the same shall have to be provided by the bidder without additional cost.

Limit state method of design shall be adopted unless specified otherwise in the specification. For design and construction of steel concrete composite beam IS: 11384 shall be followed.

For detailing of reinforcement IS: 2502 and SP: 34 shall be followed. Cold twisted deformed bars (Fe=415 N/mm2) conforming to IS: 1786 shall be used as reinforcement. However, in specific areas, mild steel (Grade-I) conforming to IS: 432 can also be used. Two layers of reinforcement (one inner and outer face) shall be provided for wall & slab sections having thickness of 150 mm and above. Clear cover to reinforcement towards the earth face shall be 40mm In case of sidewalls of cable ducts and for tower foundations & equipment foundation, clear cover shall be 50mm.

16.04.33 BOLTS NUTS AND WASHERS:

Standard bolts, nuts and washers shall be used in all works. These should be galvanized in accordance with IS: 5358.

16.04.34 PAINTING:

Outdoor Kiosk for link boxes etc., shall be painted with anticorrosive paint and red oxide as primer and two coats of enamel paint. The boxes should be appropriately labeled as per installation at site regarding the Sl. No., location, type caution board/danger board, etc.,

16.04.35 MATERIALS USED IN CABLE LAYING:

Specification in brief on the materials used in installation of the 66 KV underground cables, like RCC precast cable protection covers, precluded cement concrete blocks for cable route/joint indication, cable and mounting structures, joint bays, earthing and other miscellaneous materials are given below. All materials shall conform to relevant standards, and shall be approved by the Engineer.

16.04.36 RCC PRE-CAST CABLE PROTECTION COVERS:

These should be pre-casted as per the approved design and drawing. The reinforced cement concrete should be M20 grade (1:1.5:3 proportion) with 20 mm. and down size coarse aggregate and steel reinforcement (Fe 415 grade). The pre cast units shall be cured as per civil Engineering Standards. The covers should carry the legends KPTCL 66KV CABLES, CKT1 OR CKT2 as the case may be. The covers should be free from burrs and projecting edges

so that they may be easily laid to butt. The average breaking load shall be 450 kgs for the cover slabs.

16.04.37 CABLE ROUTE MARKERS/JOINT MARKERS:

Permanent and durable type, cable route markers/joint indicating blocks should be provided as per the design supplied by the purchaser.

The cement concrete block should be made by the wet process and the concrete shall consists of one part cement, two parts sand, four parts aggregate of size 20 mm and down.

The marking block should be given a smooth cover surface of cement mortar and shall have the appropriate legends, 5 mm deep engraved on them as "KPTCL 66 KV CABLE CKT-1" or "KPTCL 66 KV CABLE CKT-2", "KPTCL 220 CABLE CKT-1, 66KV CABLE JOINT CKT-1" or "KPTCL 220 KV CABLE JOINT CKT-1".

16.04.38 PIPES:

HDPE Pipes of ISI mark, 160 mm dia and 6 mm thickness and 230mm dia 6mm thickness approximate, of good quality shall be used for formation of cable ducts. All sundry materials like coupling, collars, caps to cover the pipe ends before cable is pulled in shall be provided.

Hume pipes and accessories conforming to IS shall be used if required. Reinforced hume pipe shall not be used for laying single core power cable, in one cable per pipe arrangement.

Stoneware pipes, salt glazed of good and approved quality shall be used.

Hume pipes without steel reinforcement, stoneware pipes can also be used where the cable passes through the passage or drive ways of public and private buildings.

In case of pipe – the size of the pipe shall be at least 30 to 40% more than size of cable. The pipe joint shall be done by using proper sleeves so as to get tight fitting. Suitable steel rope will be drawn in pipe to pull the cable. Before drawing the cable, wire brush to be drawn through pipe to clean the burrs and steel ball (sphere) shall be pushed through pipe to know whether pipe is smooth for drawing the cable.

16.04.39 SUPPORTING STRUCTURE FOR CABLE AND CABLE END TERMINATIONS:

The bidder shall quote for unit prices for support structure for each single core cable to suit the end terminations supplied by him.

These support structures shall be fabricated out of galvanized steel pipe to IS : 1239 or they shall be fabricated out of galvanized mild steel sections, such as

channels, I-beams etc., conforming to IS : 226, pipes if used for fabrication of the structure shall not have any joints.

The height of the structure shall be such that the terminal connection to receive the purchaser's ACSR Drake conductor, 50 mm diameter IPS aluminum pipe is approximately at a height of 4.5 meters. The contractor shall be furnished with relevant drawings by the purchaser.

16.04.40 The supporting structure shall be suitable to withstand the wind pressure, seismic forces and the short circuit forces, etc., and the design shall be with an adequate factor of safety as specified in I.E. rules 1956.

16.04.41 The bidder shall furnish the design and fabrication drawings, foundations, foundation anchor bolts, design calculations etc., of these structures.

16.04.42 TERMINAL CONNECTORS :

The terminal connector/clamps shall be suitable for connection to 50 mm diameter IPS aluminum pipe or Drake ACSR conductor. The terminal connector shall be of bimetallic type to connect the terminal of the cable end to the aluminum bus pipe or ACSR conductor.

The type and size of the conductor will be confirmed to the successful bidder.

The connector/clamp shall be designed to overcome :

i) Galvanic Corrosion.

ii) Thermal Cycling.

The current carrying capacity of the connector/clamps shall be greater than the maximum capacity of the power cable.

The terminal clamp shall be free from burrs, voids, blow holes.

The terminals clamps shall have passed tests for short circuit current capability and temperature rise.

16.04.43 SAND :

Sand supplied for backfill shall be river sand, and should be free from flakes, dust, earth, organic matter and large pebbles and stones and should be free from any chemical contaminants likely to have corrosive action on the cable coverings. The sand should be sieved through a mesh to remove all large stones and pebbles. The sand shall be properly graded and shall conform to IS : 383 for concreting work.

The owner will decide on the requirement of the use of sand depending on the availability of the excavated earth to be used for backfill.

The sand should be used with the approval of the owner as a backfill.

16.04.44 EARTHING :

The earthing system required is for the

i) Earthing of all non-current carrying metal parts and

ii) Earthing system for cable screens/sheath bonding at terminations.

The latest editions of the following standards and codes are applicable:

i)	IS : 3043	:	Code or practice for earthing.
ii)	IS : 2309	:	Code of practice for the protection of building and allied structures against lightning.
iii)	Indian Electricity Rules 1956	:	Provision of Rules on EHV systems.
iv)	IEE-80	:	Guide for safety in sub-station grounding.

All equipment, supporting and mounting structures of the installation shall be bonded together and connected by separate and distinct conductor to earth electrode.

16.04.45 EARTH CONDUCTOR :

The earth conductor shall be of G.I. flat, of size 50 x 6mm size and shall be protected against mechanical damage and corrosion. The connection of the earth continuity conductors to earth bus and earth electrodes shall be strong, secure and sound and shall be easily accessible.

16.04.46 PIPE EARTH STATIONS :

The pipe earth electrodes shall be in conformity with IS : 3043, buried vertically and the pit filled with alternate layers of charcoal, salt and earth. The earth lead shall be properly fastened with brass bolts, nuts and connection shall be enclosed in a masonry chamber. The chamber shall be provided with a RCC inspection cover.

16.04.46.1 The connection between the earthing terminal of equipment and earth electrode shall be made by short and direct earthing lead, free from kinks and splices.

16.04.47 The distance between any two electrodes shall not be less than twice the length of the electrode.

16.04.48 All joints shall be covered with suitable compound to protect against corrosion.

16.04.49 Earthing connections with equipment earthing terminals shall be of bolted type. The contact surfaces shall be free from scale, paint, enamels, grease, rust or dirt. Two bolts shall be provided for making each connection. The bolted connections after being checked and tested shall be painted with anticorrosive paint or compound.

16.04.50 Welds and brazed joints shall be treated with red lead and afterwards coated with bitumen compound to prevent corrosion.

16.04.51 Steel to copper connection shall be brazed type and shall betreated to prevent moisture ingress.

16.04.52 The resistance of the welded joint shall not be more than the resistance of equivalent length of the conductor.

16.04.53 All welded joints shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature.

16.04.54 Arc welding with large diameter conductor shall be done with low hydrogen content electrodes.

16.04.55 BONDING OF CABLE SCREENS/SHEATH :

Each single phase cable shall have a separate earth for the screen earthing. The system short circuit level is 40kA for 1 Sec for 66kV UG cables. The earthing lead at solid earth positions shall be single core, 240 sq. copper conductor, PVC insulated, 3.3KV voltage grade cable.

16.04.56 EARTH TESTS :

Tests on earths shall be carried out by the contractor for testing the effectiveness of earth resistance of electrodes and the results furnished to the owner.

17.00.00 **TESTING, COMMISSIONING, TYPE/ROUTINE TESTS ON CABLES AND ACCESSORIES**

17.01.00 GENERAL :

17.01.01 The material and equipment covered under this contract are subject to strict codes of owner approved Q.A.P., inspection and tests.

17.01.02 The Engineer or his authorized representative shall have, at all reasonable times access to the contractor's premises to inspect and examine the materials during manufacture and if part of the equipment is being manufactured or assembled on other premises or works, the bidder shall arrange and obtain permission for the purchaser as if the equipment/material is manufactured at the bidder's own premises. The Owner will depute Three Engineers from KPTCL/ BMRCL for inspecting the equipments / materials. The Visa, to and fro travel expenses from the place of working of officials deputed for inspection, boarding charges, lodging charges and other incidental expenses of the inspecting Engineers for inspections to be carried out outside the country are to be borne by the Contractor.

17.01.03 The inspection requirement for material shall conform to the design, assembly fabrication and tests defined in the reference code of standards.

17.01.04 Approval or passing of any such inspection by the owner shall not however, prejudice the right of the owner to reject the material equipment, if it does not

comply with the specification when installed and or fails to give the intended service.

17.02.00 NOTICE OF INSPECTION:

17.02.01 The contractor shall give the owner thirty days written notice of any material being ready for inspection and tests.

17.02.02 The Engineer shall, within fifteen days of the inspection, give notice in writing to the bidder of any defects noticed during inspection. The bidder shall take corrective measures and shall confirm in writing, of the compliance or otherwise with due reason.

17.02.03 The Engineer shall issue a certificate for having inspected the material/equipment within thirty days of inspection. The issue of the certificates does not bind the purchaser to accept the material should it on further tests on installation be found not to comply with the contract specification.

17.02.04 In the case of stage inspection, the bidder shall proceed from one stage to another only after the component is inspected by the owner and permission given to proceed further. The same procedure shall apply for any rectification or repairs suggested by the owner.

17.02.05 The purchaser or the Engineer, shall have the right to inspect any machinery, material, structure, equipment, plant or workmanship furnished or used by the contractor and may reject any or all which is defective or unsuitable for the use and purpose intended or which is not in accordance with the specification.

The contractor on demand by the owner shall remedy or replace at his expense such defective material/plant equipment. In the event of the failure by the contractor for correcting the defect or replacement of the material/equipment plant, the owner may take such remedial measures necessary, at the expense of the contractor.

17.02.06 On the material to be supplied under this contract, it is to be noted that it shall not relive the contractor of his responsibility for supplying material conforming to requirement of the contract, nor prejudice any claim right or privilege which the owner may have because of the use of defective material.

Should the purchaser waive the right to inspect any item of the material, such waiver shall not relive the contractor in any way from his obligation under the contract.

In the event of inspection by the engineer, and the inspection revealing goods/materials not in conformity with the standard/specification, the owner

shall specify additional tests/inspection procedures, if required to ascertain compliance with specifications.

17.02.07 A set of latest relevant approved drawings/data shall be made available to the Engineer during inspection.

17.03.00 TEST ON MATERIALS SUPPLIED BY SUB CONTRACTORS :

The plant or equipment supplied by the sub-contractor of the bidder shall comply in every respect to the specification and applicable tests.

17.04.00 TEST MATERIAL:

The bidder shall provide test pieces, as required, in quantity, to determine the quality of material supplied under this contract. If any test piece fails to comply with the requirement the Engineer may reject the whole material represented by the test pieces.

17.05.00 TESTS AT MANUFACTURER'S WORKS:

17.05.01 The test at works shall include the electrical, mechanical and hydraulic and other special tests in accordance with the relevant standards.

A complete test schedule/program shall be furnished by the contractor.

The contractor shall carry out all the tests as specified by the owner, under tests for relevant material.

17.05.02 Test certificate include, test records and performance graphs, drawings which shall be supplied to the owner. All tests shall be carried out in accordance with the provisions of the contract.

All test certificates must be endorsed with sufficient information to identify the material or equipment to which the certificate refer, and must carry in the top right hand corner the identification of the owner and the contract.

20kV DC voltage test between the metallic sheath and the outer sheath for each and every length of the cable delivered should be conducted and the sheath leakage at 10kV, 15kV and 20kV are to be furnished and got approved before dispatch of cable drums. The leakage current shall be within limits of 5.0mA for 500mtrs at 20kV DC and 2.0mA for 500mtrs at 10kV D.C.

17.05.03 The routine acceptance and type tests conducted in the presence of the Engineer, and the test certificates shall be approved before the materials are dispatched.

17.06.00 MANUALS AND LITERATURE ON MATERIAL/ EQUIPMENT

The bidder shall enclose with his offer all literature and materials relevant to the contract and in particular

i) On cable offered.

ii) On cable jointing and terminating techniques.

iii) Instructions on cable installation, storage, handling, maintenance, fault finding, repairs, preventive maintenance, etc.,

iv) Literature on special Tools & Plant.

v) Literature on sheath bonding, maintenance of link boxes.

vi) Any other relevant literature/manual.

17.07.00 TESTS :

17.07.01 The contractor shall make available to the Engineer a complete set of detailed data, required for inspection and tests.

17.07.01.1 Routine & Acceptance tests shall be conducted at the factory by the contractor in accordance with the relevant standard code to determine the performance and characteristics of material equipment/ accessory and to determine whether or not the guarantees of quality have been met.

17.07.01.2 Not used

17.07.01.3 Routine and acceptance tests shall be conducted in accordance with the relevant IEC 60840/2011

17.07.02 TYPE TESTS :

The contractor shall indicate that the equipment/material offered has successfully passed the type tests as required by the relevant standard.

Relevant type test certificates shall be furnished along with the bids to prove the quality of the material/equipment including those of the accessories.

The bidders shall agree to conduct all or repeat the tests already conducted, for the satisfaction of the purchaser.

17.08.00 ELECTRICAL TESTS AFTER INSTALLATION :

17.08.01 The contractor shall conduct the following tests during and after installation as per IEC 60840/2011

17.08.02 In the event of the installation failing the tests, the contractor shall at his expense, identify the cause and rectify the defects, and render the installation serviceable.

17.08.03 D.C. TESTING :

* As per IEC 60840, D.C. tests shall not be conducted on main Insulation. D.C. tests shall be carried out on outer sheath and shall be conducted as per Clause No 16.2 of IEC 60840
* Polarisation Index test.
* After laying, jointing and terminating the cables shall be tested with all accessories.
* The above tests shall be carried out by the vendor in the presence of owners' representative.

* Should a breakdown of the sheath occur during these tests, the vendor shall locate the fault and repair the cable(s) after owner's agreement until the retests give satisfactory results for the total link.
* All expenses in connection with the civil works which are made necessary for faults location and repair shall be borne by the vendor including additional costs for the services rendered by the owner

17.08.04 A.C. TESTING :

The installation shall be tested with AC voltage at power frequency for main insulation as per clause no. 16.3 of IEC 60840.

The power frequency voltage as per table no.4, column 10 of IEC 60840 (72kv) shall be applied for one hour.

Alternatively a voltage of U0 phase to earth voltage (36kV) may be applied for 24hours.

17.08.05 TEST ON NON METALLIC SHEATH :

The non-metallic sheath shall be subjected to test as per IEC publication 60229.

17.08.06 The bidder can recommend any other test, for satisfactory performance of the installed system.

18.00.0 PRE- COMMISSIONING – ELECTRICAL TESTS AFTER INSTALLATION:

On completion of cable laying, jointing and termination works the complete installation will be tested with.

DC voltage test on over sheath as above for complete installation.

Sheath fault occurring during laying, testing after laying and during pre-commissioning should be rectified by the vendor free of cost (including civil works) Necessary sheath repairing kits with heat shrinkable materials are to be supplied as per the site requirement during execution of works.

The following pre-commissioning tests shall be carried out by the VENDOR after installation.

1. Electrostatic capacitance of the cable
2. Resistance of the cable conductor.
3. Resistance of the Sheath.

These tests should be got done by CPRI.

The vendor is requested to quote testing charges.

The owner reserves the right to witness all the tests and the vendor shall provide all facilities to the owner in this regard. The date of testing will be informed by the owner sufficiently in advance to the vendor's supervising engineer, to enable the

vendor to carry out the tests.

The vendor should furnish (5 copies) of the test results for calculating the total losses.

The observation period shall be one month of operation after energizing of the cable. For this period of one month the cable circuits will be operated by KPTCL under normal conditions.

If a breakdown occurs on the cables or accessories during this period, all repairs shall be made by the vendor at his own expenses including civil works and road cut restoration charges. Owner reserves the right to request to change the full length of cables between the two joints chambers, free of charge including duties and taxes etc., this shall not apply for injuries of external origin.

After the verification is done, field tests shall be carried out again according to site tests specified in the tender clause.

The observation period shall be 3 months of operation after repairs and re-energisation. No breakdown shall occur. If breakdown occurs again on the cable & accessories during this period, all repairs & replacement shall be made by the vendor as given in the above para. When the observation period is completed, the guarantee period will start.

19.00.00 DOCUMENTATION

The following documents should be furnished:

a) Along with the bid :

1) Dimensioned cross sectional details of the cable.
2) Current carrying capacities "with supporting calculated data" of the cable and derating factors.
3) Manual of instructions on cable handling and cable laying.
4) Type, acceptance and routine test certificate on the cable as per relevant IS, IEC or other national standards.
5) Dimensioned cross sectional details of the straight through Joint kit along with bill of materials.
6) Manual of instructions on the method and formation of the straight through joint.
7) Type, acceptance and routine test certificate on the straight through joints.
8) OGA drawing of the cable end termination.
9) Dimensioned cross sectional details of cable end terminations with bill of materials.
10) Manual of instructions on the method and formation of the cable end termination.

11) Type, acceptance and routine test certificate on the cable end termination.
12) OGA drawing of the cable termination structure along with the bill of materials.
13) Foundation drawing of the cable terminating structure.
14) Civil Engineering details of jointing bays with cross sectional elevation and plan.
15) Dimensioned cross sectional details and plan of cable trench/duct/road crossing showing the position of cable.
16) Dimensioned cross sectional drawing of the pipe electrode earthing along with bill of materials.
17) Drawing showing the method of bonding of the cable screen/sheath and the earth connection.
18) Drawing of RCC cable protection cover.
19) Calculation of induced voltage in the sheath & the recommended method of bonding.

b) On award of the contract:

1) The contractor shall prepare the route layout plan indicating the road crossing, crossing across drains, nallahs, etc., and location of the straight through joints along with all other relevant and associated drawings.
2) The owners will communicate approval to the drawings furnished in respect of the supply as well as for the installation portion within one month on execution of the contract agreement.

ANNEXURE – TS 1

CLASSIFICATION OF SOIL STRATA

1.0 Ordinary Soil :

This shall comprise of vegetable or organic soil, turf, sand, sandy soil, silt, loam, clay, mud, red earth, suade, peat, black cotton soil, soft shale, loose murrum, mud debris, concrete below ground level, a mixture of all these and similar material which yields to the ordinary digging implement. Removal of gravel or any other modular material having diameter in any one direction not exceeding 75 mm, such occurring strata shall be deemed to be covered under this category.

2.0 Hard Soil :

This includes:

1) Stiff heavy clay, hard shale or compact murrum requiring digging tool or pick or both and shovel closely applied.
2) Gravel, soft laterite, Kankar and cobble stone having maximum diameter in any one direction between 75 mm and 300 mm.
3) Soiling of road paths, etc., and hard core.
4) Macadam surfaces such as water bound and bitumen/tar bound.
5) Lime concrete, stone masonry in lime/cement mortar below ground level.
6) Soft conglomerate, where the stones may be detached from the matrix with picks.
7) Generally any material which requires the close application of picks or scarifies to loosen and not affording resistance to digging greater than hardest of any soil mentioned in item (1) to (6) above.

3.0 Ordinary Rock :

1) Ordinary rocks comprising of limestone, sand stone, hard late rite, fissured rock, conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars.
2) Un-reinforced cement concrete which may be broken up with crow bars or picks and stone masonry in cement mortar below ground level.
3) Boulders, which do not require blasting having maximum diameter in any direction of more than 300 mm found lying loose on the surface or embedded in river bed, soil, talus slope wash and terrace material of dissimilar origin.

   Note: Hard laterite does not require blasting. It is to be classified under ordinary rock which does not require blasting.

4.0 Hard Rock :

This shall comprise:

Any rock or cement concrete or RCC for the excavation for which the use of mechanical plant or blasting is required.

Hard rock shall be removed by blasting where the same is permitted. In restricted places, hard rock shall be removed by chiseling and wedging/controlled blasting without causing inconvenience to the normal life and endangering the life and property and other utilities.

ANNEXURE-A

PROCEDURE AND SPECIFICATION PRESCRIBED BY BBMP TO BE FOLLOWED FOR RESTORATION OF ROAD

1) KPTCL/BMRCL should adhere to the action plan (bar chart) submitted. Failing which permission to lay further routes will not be permitted. Decision of the Commissioner in this regard is final.
2) Permission is valid for permitted period only. In case of expiry of permitted period, extension of time will be granted on genuine reasons which is discretionary and attract extra fees as applicable.
3) Non-refundable supervision charges at 10% of restoration cost and road cutting permission fees at 10% of restoration cost has to be deposited to BBMP before obtaining permission. This has to be deposited before obtaining permission.
4) Caution deposit at 25% of restoration cost has to be deposited to BBMP, which is refundable subject to satisfactory restoration as per specifications. This has to be deposited before obtaining permission.
5) Next route will be permitted and caution deposit will be refunded on production of satisfactory restoration report from the jurisdictional Executive Engineer of BBMP.
6) Restoration work like back filling excavated trench with sand, gravel sub-base, wet mix macadam, bituminous macadam and re-surfacing full width of road by 40mm bituminous concrete as per PWD specification.
7) If restoration work is not executed as per specifications of current NH/PWD SR lay down by BBMP, in such cases if defective portion noticed is not rectified, same will be taken up by BBMP out of caution deposit deposited by KPTCL.
8) Trenching should be taken up in 450 mtrs stretches at a time only and should be restored as per specifications immediately.
9) Back filling materials like sand and Wet Mix Macadam (WMM) should be stacked at work site before taking up trenching work. Commencement of trenching and cable laying work has to be intimated to the concerned area AE/AEE/EE of concerned division of BBMP.
10) Any over burden debris/earth should be removed and conveyed to dumping yard irrespective of distance.

11) Restoration work has to be carried out in presence of BBMP officials, Time and date of restoration work should be intimated well in advance to the respective Zonal Engineers of BBMP.

12) Follow the procedure as laid down in road opening and restoration protocol. Barricading, caution boards and other precautionary signages, name and telephone numbers of the agency, opening and closing date shall be displayed during the execution of the work..

13) HDD method of laying cable should be carried out at critical junctions and important approaches like hospitals and other important buildings.

14) Laying of electric UG cable should not damage any of the BBMP properties, and has to be taken below the shoulder drain/drain. Ensure that no damage is caused to trees.

15) Luminous tape/ribbon indicators are to be used to demark the work area and provide safety to road users & pedestrians as per MORTH.

16) Warning lights should be provided while working at night.

17) Any unauthorized opening by way of HDD pits/lengths beyond the permitted length will invite strict consequences as per law including penalty.

18) Any damage to private property, Government property, BBMP property and lives caused due to your work has to be rectified / fulfilled by KPTCL/BMRCL.

19) Quality control result has to be furnished from recognized agency before releasing of Caution deposit.

20) Permission from traffic police authorities has to be obtained before execution of work.

21) Hard copy and soft copy of ongoing restoration work and after completion work should be submitted to BBMP for record purpose.

22) Trenching has to be taken up 0.3Mtrs away from the kerb stone.

SPECIFICATION FOR ROAD RESTORATION

Note: For detailed specifications KPWD SR of Bangalore Circle and NH SR shall be referred.

(a) **Providing riddled/sieved River sand:** Supplying, handling and spreading riddled / sieved River sand in the cable trench, forming cushion and cover around cables including watering, compaction etc complete as per specifications, drawings and directions of the Engineer in charge of the work.

(b) Providing Granular Sub-Base : Construction of Granular Sub-Base by providing coarse graded material, spreading in uniform layers with motor grader on prepared surface, mixing by mix in place method with rotavator at

OMC, and compacting with vibratory roller to achieve the desired density, complete as per Table 400-1 of KPWD SR for grading-1 material.

(c) Providing wet mix macadam :- Providing. Laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing the materials with water at OMC in mechanical mix plant carriage of mixed material by tipper to site, laying in uniform layers with paver in sub-base/base course on well prepared surface and compacting with vibratory roller to achieve the desired density. Material (Table 400-11) clause: 406 of KPWD SR.

(d) Providing bituminous macadam :- Providing and laying bituminous macadam using crushed aggregates as per table 500-4 of specified grading premixed with bituminous binder 60/70 grade (VG-30) in batch/Hot mix plant, loading of aggregates with F.E.loader, transported to site in tipper to paver, laid over a previously prepared surface with hydrostatic paver finisher with sensor, control to the required grade, level, alignment, rolling with smooth wheeled tandem roller 6-8 tonnes as per clause 501.6 and 501.7 to achieve the desired compaction, including the cost of all materials, labour hire charges of machinery, lead, lifts, loading , unloading, stacking, transporting etc complete excluding cost of primer/tac coat (compacted thickness 75mm) (Grading2) with 3.3% Bitumen. Ref. NH SR.

(e) Providing bituminous concrete :- Providing and laying bituminous concrete 40mm thick with 40-60 TPH hot mix plant using crushed aggregates of specified grading, premixed with bituminous binder @ 5 percent of mix and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction as per MORTH specification clause No. 509 of KPWD SR complete in all respects (Bitumen=0.117. Metal=1.462, cement=0.0504MT) over B.T. surface using 60/70 grade bitumen.

(f) Primer Coat: Providing and applying primer coat with bitumen emulsion on prepared surface of granular base of low porosity as WBM and WMM including clearing of road surface and spraying primer at the rate of 0.75Kg/Sqm using mechanical means. As per MORTH specification clause No. 502 complete in all respect.

(g) Tack Coat: Providing and applying Tack coat with bitumen emulsion using emulsion pressure distributor at the rate of 0.225Kg/Sqm on the prepared

on normal bituminous surface cleaned with mechanical broom . As per MORTH specification clause No. 503 complete in all respect.

ANNEXURE-B

TECHINCAL SPECIFICATIONS OF UNARMOURED U/G FIBRE OPTIC CABLE

This section describes the functional requirements, major technical parameters and Type and Factory Acceptance Testing requirements for underground fibre optic cable, Marking, Packaging and transportation requirements have also been described.

2.1 General

The Underground fibre optic cable shall be unarmoured and shall be suitable for underground installation in pipes. The cable should be of low weight, small volume and high flexibility. The mechanical design and construction of each unit shall be inherently robust and rigid under all condition of operation, adjustment, replacement, storage and transport.

2.2 Applicable Standards:

The cable shall conform to the standards named below and the technical specifications described in the following sections.

(i) ITU-T Recommendations G-652.

(ii) Electronic Industries Association, EIA/TIA 455-78A, 455-3A, 455-62A, 455-164A/167A/174. 455-168A/169A/175A, 455-176, 455-59, EIA/TIA 598, EIA 455-104.

(iii) International Electro technical Commission standards, IEC 60304, IEC 60794-1-2, IEC 60811-5-1.

(iv) Bell Core GR-20.

2.3 Fibre Type (S) and Counts.

The cable shall contain 12 Dual window single Mode (DWSM) fibres conforming to G.652 as per the bill of the quantity and the technical parameters stipulated in the following sections. The BOQ for each type of cable has been provided in the appendices.

2.4 Optical Characteristics:

The attenuation coefficient for wavelength between 1525nm and 1575nm shall not exceed the attenuation coefficient at 1550nm by more than 0.25dB/km. The attenuation coefficient between 1285nm and 1330nm shall not exceed the attenuation coefficient at 1310nm by more than 0.35 dB/Km. The attenuation of the fibre shall be distributed uniformly throughout its length such that there are no point discountinies in

excess of 0.1db. The fibre attenuation Characteristics specified in table 2-1 shall be "guaranteed" fibre attenuation of any & every fibre reel. Further the average cabled fibre attenuation, averaged over 100 Kms of cabled fibre, (as measured during the factory acceptance testing) shall be as specified in 2 –1.

Table 2-1

DWSM Optical Fibre Characteristics

Fibre Description:	Dual window Single-Mode
Mode Field Diameter:	8.6 to 9.5nm um (K10% of the nominal value)
Cladding Diameter:	125.0 um K 2um
Mode Field concentricity error:	=1.0um
Cladding non-circularity	=2%
Cable cut off wavelength	=1260nm
1550 loss performance	As per G.652
Proof Test Level	=0.35Gpa
Attenuation coefficient Max	@1310nm = 0.35 db/Km @1550nm = 0.25 db/Km
Tube	Base tube
Fiber Type	High performance 'AT'
Giga Bit Ethernet Distance	10,000Mtrs (1310nm)
10 Giga Bit Ethernet Distance	5,000Mtrs (1310 nm) 30,000Mtrs (1550nm)
Connector loss Sprice loss	0.75dB 0.1dB } for both 1310 & 1550nm type
Outer jacket	0.65ms polymide -12 (orange)
Rip cord	to be provided.
Chromatic Dispersion: Maximum: Zero dispersion wavelength: Zero Dispersion Slope	20ps/(nm x km) 1550nm 3.5ps/(nm x km) 1288-1339nm 5.3ps/(nm x km) 1271-1360nm 1300 to 1324 nm -0.093ps/(nm² x km) maximum
Polarization mode dispersion coefficient	=0.5 ps/km ½
Blend performance	@1310nm (75=2nmdia Mandrel), 100 turns Attenuation rise <0.05 db/km @1550nm (75=2nmdia Mandrel), 100 turns

	Attenuation rise <0.10 db/km @1550nm (32=0.5 dia Mandrel), 1 turn: Attenuation rise <0.50 db/km

2.5 General Construction:

The Optical cable shall consist of a central fibre optic unit protected by one or more layers of helically wound anti-hygroscopic tape or yarn. The central fibre optic unit shall be designed to house and protect the fibres from damage due to forces such as crushing, bending, twisting, tensile stress and moisture, wide temperature variations, hydrogen evolution etc. The fibre shall be of loose tube construction. The inner polyethylene jacket and outer sheath packets shall be free from pinholes, joints, splits or any other defects. All fibre optic cable shall have a minimum service life span of 25 years.

2.5.1 Colour Coding & Fibre Identification:

Individual optical fibre within a fibre unit, and fibre units shall be identifiable in accordance with EIA/TIA598 or IEC 60304 or Bellcore GR-20 Colour – coding scheme. The colour coding system shall be discernible throughout the design life of the cables. Colouring utilized for colour coding optical fibres shall be integrated into the fibre coating and shall be homogeneous. The colour shall not bleed from one fibre to another and shall not fade during fibre preparation for termination or splicing. Each cable shall have tracibility of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre. If more than the specified number of fibres included in any cable, the spare fibres shall be tested by the cable manufacturer and any defective fibre shall be suitably bundled, tagged and identified at the factory by the vendor.

2.5.2 Strength Members

The Central fibre optic unit should include a central strength member of Fibre Reinforced Plastic (FRP) or other suitable material. Peripheral strength members and aramid yarns are also acceptable. The Central FRP strength member may be of slotted type with SZ lay (reverse oscillation lay) of fibre units or it may be cylindrical type with helical lay of fibre units.

2.5.3 Filling Compound:

The interstices of the central fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any longitudinal water migration within fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC60794-1-2F5. The filling compound used shall be a non-toxic homogeneous water proofing compound that is free of dirt and foreign matter, anti-hygroscopic, electrically nonconductive and non-

nutritive to fungus. The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable. The filling compound shall remain stable for ambient temperature 40 to –70 deg C and shall not drip, flow or leak with age or at change of temperatures reference method to measure drip point shall as per IEC 60811-5-1 and drip point shall not be less than 70deg C.

2.5.4 The Sheath /Inner Jacket:

The sheath shall be black, smooth, concentric, and shall be free from holes, splits, blisters and other surface flaws. The sheath shall be extruded directly over the central fibre optic unit and shall also be non-hygroscopic. The cable sheath design shall permit easy removal without damage to the optical fibres or fibre units. The sheath shall be made from good quality of weather resistant polyethylene compound (Black High Density Polyethyelene-HDPE) and thickness shall be = 1.8mm. code 'A' for polyethelene.

2.5.5 The Outer Jacket /Termite Protection

The circular jacket of not less than 0.65mm Polymide –12 (orange Nylone –12) material should be applied over the sheath as an outer jacket. The outer jacket shall have smooth finish and shall be termite resistant.

2.5.6 RIP Cord: Suitable rip cord(s) shall be provided to open the outer sheath of the cable. The rip cord (s) shall be properly waxed to prevent wicking action and shall not work as a water carrier.

2.6 Mechanical parameters & Tests

a. Tensile strength: The cable shall be of sufficient strength to withstand a load of value T(N)=9.81 x 2.5 x W Newton or 2670 N whichever is higher (Where W is the mass in Kg of 1 Km cable). The load shall be sustained for 10 minutes and the strain of the fibre monitored. The load shall not produce a strain exceeding 0.25% in the fibre and shall not cause any permanent damage to any constituent part of the cable. The change in optical attenuation during or after the application of the compressive load shall not exceed 0.05dB/Km both 1310nm and 1550nm wavelength. The attenuation shall be noted before and after the test for all the fibres.

b. Crush test (Compressive Strength): The cable shall withstand a compressive force of at least 2000N applied for at least 60 seconds between two plates of 100mm x 100mm in accordance with IEC60 794-1-2 E3 procedure. This compressive load applied in accordance with IEC60 794-1-2-E3 shall not cause

any permanent damage to any constituent part of the cable. The change in optical attenuation during or after the application of the compressive load shall not exceed 0.05dB/Km both 1310nm and 1550nm wave length. The attenuation shall be noted before and after the test for all the fibers.

c. Bend Radius: The cable bend radius under no load shall be less than or equal to 20 times the cable diameter. The test method shall be according to the IEC 60794-1-2-E11 (Procedure-I). The fibres and component parts of the cable shall not suffer permanent damage when the cable is repeatedly wrapped and unwrapped 4 complete turns of 10 complete cycles around a mandrel of 20 times to the cable diameter. The change in optical attenuation after the test shall not exceed 0.05dB/Km both for1310nm and1550nm wavelength. The attenuation shall be noted before and after the test for all the fibres. Outer jacket shall not show any cracks visible to the naked eye when examined whilst still wrapped on the mandrel.

d. Cable Bending test (Repeated bending): The cable shall withstand repeated bending when tested in accordance with EIA-455-104 and shall not cause any permanent damage to any constituent part of the cable. The cable sample shall be at least 5 meters or more. The change in optical attenuation during or after the application of the repeated bending test shall not exceed 0.05dB/KM for all the fibres. The attenuation shall be noted before and after the test for all the fibres. The test requirement shall be as mentioned below:-

Weight	5Kg
Minimum distance from pulley center to holding device	216 mm
Minimum distance for weight to pulley center	457mm
Pulley diameter	20 times to the cable dia
Angle of turning	90°
No. of cycles	30
Time required for 30 cycles.	2 min.

e. Impact Test: The cable shall withstand at least 10 impacts of 50 N load from a 0.5 meter height with impacting surface radius of 300mm. This impact load applied at the same place in accordance with IEC 60794-1-2-E4 shall not cause any permanent damage to any constituent part of the cable. The change in optical attenuation during or after the application of the impact load shall not exceed 0.05db/Km. The attenuation shall be noted before and after the test for all the fibres.

f. Torsion Test: The cable shall withstand 10cycles of ±180° torsion with 100N load applied on a 2m sample. This load cycle applied in accordance with IEC 607694-1-2-E7 shall not cause any permanent damage to any constituent part of the cable. The change in optical attenuation during or after the application of the torsion load shall not exceed 0.05Db/km for all the fibres. The attenuation shall be noted before and after the test.

g. Kink test (Resistance): When a cable of sample length 10 times the minimum bend radius as defined above is subjected to kinking, it shall not result in any fibre breakage and the kink shall disappear after normalizing the cable. The change in optical attenuation after the application of the kink in accordance with IEC60794-1-2-E10 shall not exceed 0.05 db/km for all the fibres.

h. Water penetration test (Resistance to water ingress): The resistance to water ingress of the cable shall meet or exceed the test performance criteria as per IEC 60794-1-2 F5 method F5B.Before applying the water tight sleeve at one end the outer jacket shall be stripped. A water soluble fluorescent dye shall be used for testing. The duration of tests shall be 7 days. In addition after the test the cable shall be ripped open and distance up to which water has seeped shall be noted.

i. Drip test (Seepage of Filling Compound): For testing, a sample of 30 cm length of the cable with one end sealed by the end cap will be taken and outer jacket, sheath, binder tapes shall be removed by 5 cms from open end of the sample. The filling compound will be wiped thoroughly and the sample be kept vertically with open end down ward in the oven for 24 hours at 70°C temperature with a filter paper under the sample. The filter paper should not indicate any sign of drip or oily impression. The reference test specification shall be as per IEC 60811-5-1 to measure drip point.

j. Environmental Test: Temperature cycling test shall be carried out on one drum length of the cable to ensure stability of attenuation parameter of the cable when subjected to temperature change which may occur during storage, transportation, and operation. The permissible temperature range for storage and operation will be from -20°C to -70 °C. The rate of change of temperature during test shall be 1°C per minute. The cable shall be kept for 12 hours at each of the following temperature and should follow the specification IEC 60794-1-2-F1. Two cycles shall be performed.

TA2	: -20°C
TA1	: -10-°C

TB1	: +60°C
TB2	: +70°C

The attenuation shall be measured at the end of each temperature range both at 1310nm&1550nm.The change of attenuation of fiber used shall be=0.05dB both for 1310nm&1550nm for entire range of temperature for all the fibers in each cycle.

k. Termite Resistance Test: The outer jacket shall be demonstrated to be termite resistant. The exact procedure for the test shall be mutually agreed between the Contractor and the Employer and shall generally be in line with test procedures followed by reputed test laboratories.

l. Abrasion Test: To be conducted as per IEC 60794-1-E2 or equivalent international test method.

m. Flexure Rigidity Test: To be conducted as per ASTM D-790. The test shall not cause any permanent damage to any constituent part of the cable. The change in optical attenuation after the test shall not exceed 0.05dB/km. The attenuation shall be noted before and after the test for all the fibres.

n. Figure of Eight Test: 1000m of cable shall be uncoiled from the drum and arranged in figure of eight, each loop having a maximum, dimension of 2 m. It shall be possible to arrange cable in figure of 8 with relative ease and the cable shall not show any visible damages.

o. Cable Ageing Test: After Environmental test the cable shall be subjected to a temperature of 85± 2° C for 168 hours. Cable shall then be brought to ambient temperature and stabilized for 24 hours. The change in optical attenuation after the test shall not exceed 0.05dB/Km. For 1310 as well as 1550nm wavelengths. The attenuation shall be noted before and after the test for all the fibres.

p. Embrittlement Test of Loose Tube: The minimum length of the test sample depend of the outside diameter of the loose tube and should be 85mm for tubes upto 2.5mm outside dia. The length of the bigger tubes should be calculated by using the following equation:

$Lo > 100 \times ((D^2 + d^2)/4)^{1/2}$

Where

Lo = Length of tube under test

D = Outside dia of loose tube

D = Inside dia of loose tube

Both the ends of a buffer tube test sample may be mounted in a tool which is clamped in jaws of a tensile machine which exert a constant rate of movement. The movable jaw may move at a rate if 50mm per minute toward the fixed jaw. Under load the tube will bend so that the tube is subjected to tensile and compressive stresses. The fixture for holding the tube should be designed in a manner that the tube might bend in all directions without further loading. The tube should not get embrittled. No ink should appear on the tube upto the safe bend dia. of tube (20D) where D is the outside diameter of the loose tube. There should not be any physical damage or mark on the tube surface.

q. Kink Resistance test on the loose tube: A longer length of the Loose tube is taken (with fibre and gel), a loop is made and loop is reduced to the minimum bend radius of loose tube i.e., 20D (Where D is the outside dia of the loose tube). This test is to be repeated 4 times on the same sample length of the loose tube. No damage or kink should appear on the surface of the tube.

r. Drainage test for loose tube: A tube length to 40Cm shall be cut and filled with filling gel ensuring there are no air bubbles and the tube is completely full. The filled tube is placed in a horizontal position on a clean worktop and cut 5cm from each end so that the finished length of the sample is 30Cm The filled tube shall be left in a horizontal position at an ambient temperature for 24 hrs. The sample tube is then suspended vertically in an environment heat oven over a weighed breaker. It is left in the oven at a temperature of 70 °C for a period 24 hrs. At the end of the 24 hrs period the breaker is checked and weighed to see if there is any gel in beaker. There shall be no gel or oil in the beaker.

s. Check of easy removal of sheath: The sheath shall be cut in circular way using a sheath removal tool and about 300mm length of the sheath should be removed in one operation. It should be observed during sheath removal process that no undue extra force is applied and no component part of the cable is damaged. It shall be possible to remove the sheath easily. Easy removal of both the outer jacket and the inner sheath shall be checked separately.

t. Effect of aggressive media on the cable surface (Acidic and alkaline behavior): The test shall be conducted as per method No. ISO-175. The two test samples of the finished cable each of 600mm in length are taken and the ends of the samples shall be sealed. These test samples are put in the PH4 and PH10 solutions separately. After 30 days these samples are taken out from the solutions and examined for any corrosion etc. on the sheath and other markings of the cable. The sample should not show any effect of these solution of the sheath and other marking of the cable.

2.7 Cable drums, Marking, Packing and Transport:

All optional fibre cable shall be supplied on strong wooden drums provided with lagging with adequate strength, constructed to protect the cabling against all damage and displacement during transit, storage and subsequent handling during installation. The cable drum shall be suitable to carry underground fibre optic cable of length 2KM +/- 10% and 4KM +/- 10%. The contractor may offer higher cable drum length in straight routes subject to transportation handling and installation limitations. However, the exact lengths for drums to be supplied for each link shall be determined by the contractor during detailed engineering/survey. Drum schedule shall be got approved by the Employer before manufacturing FO cable. Both cable ends in the drum shall be sealed and shall be readily accessible. The drum shall be marked with arrows to indicate the direction of rotation, both the ends of the cable shall be provided with pulling eye. The pulling eye and its coupling system should withstand the same tensile load as applicable to the cable. The following marking be done on each side of the cable drums.

i) Drum No.
ii) Consignee's name and address.
iii) Contractors name and address.
iv) Type of cable
v) Number of fibres
vi) Type of fibres
vii) Year of Manufacturing, month & batch No.
viii) Name of Manufacturer.
ix) Total cable length
x) Inner end marking and outer end marking.

Packing list supplied with each drum shall have all the information provided on marking on the respective cable drum and following additional information: OTDR length measurement of each fibre and ratio of fibre and cable length.

2.7.1 Optical Fibre Cable marking:

A suitable marking shall be applied in order to identify this cable from the other cables. Marking on the cable shall be indelible of durable quality, shall last long and shall be applied at regular interval of one –meter length. Marking shall be imprinted and must clearly contrast with the surface and colors used must withstand the environmental influences experienced in the field.

The accuracy of the sequential marking must be within ±0.5% of the actual measured length. The sequential length marking must not rub off during normal installation. In case laser printing is used the marking shall not exceed 0.15mm depth. The optical fibre cable shall have the following marking in every meter.

i) Type of cable
ii) Running meter length
iii) No. of fibres
iv) Type of fibre
v) Laser symbol & caution notice
vi) Year of manufacture and batch No.
vii) Manufacturer' name
viii) DTL

2.7.2 Operating Instructions:
Complete technical literature in English with detailed cable construction diagram of various sub-component with dimensions and test data of the cable shall be provided. All aspects of installations shall also be covered in the handbook.

2.8 Test and Inspection:
The general conditions for Type and Factory Acceptance Testing shall be as per section 6. Type test shall be as section 6.3. Sampling plan for FAT shall be as per section 6.4.1.

2.8.1 Type testing the test mentioned in Section 2.6 shall be carried out as type test for fibre optic cable & the tests listed in table 2-2 shall be carried out as type tests for fibres.

Sl. No.	Test Name	Acceptance criteria	Test Procedure.
1.	Attenuation	TS Table 2-1	EIA/TIA 455-78A
2.	Attenuation Variation with wavelength	TS Table 2-1	EIA/TIA 455-78A
3.	Attenuation of Water Peak	TS Table 2-1	EIA/TIA 455-78A
4.	Temp. Cycling (Temp. dependence of Attenuation)		EIA/TIA 455-3A 2 cycles
5	Attenuation with Bending (Bend Performance)		
	Table 2-2: Type Tests	For Optic Fibres	
Sl. No.	Test Name	Acceptance Criteria	Test Procedure

6.	Mode Field dia.		EIA/TIA 455 –164A/ 167A/174
7.	Chromatic Dispersion		EIA/TIA 455 –168A/ 169A/175A
8.	Cladding Diameter		EIA/TIA 455 –176
9.	Point Discontinuities of attenuation		EIA/TIA 455 –59
10.	Core – clad Concentricity error		EIA/TIA 455 –176

2.8.2 Factory Acceptance Testing:

The tests listed in Table 2-3 shall be carried out as Factory Acceptance Test for underground fibre optic cable.

Table 2-3

Factory Acceptance Tests on Underground Fibre Optic Cable

Sl. No.	Factory Acceptance Test
1	Attenuation Co-efficient (1310, 1550 and water Peak)
2	Point discontinuities of attenuation
3	Chromatic Dispersion
4	Visual Material Verification and Dimensional Checks as per approved drawings
5	Resistance to water Ingress test
6	Tensile Strength test/Strain Test
7	Impact test
8	Kink test

2.9 QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under the scope of contact, whether manufactured or performed within the contractors work or at his sub contractors premises or at the owners site or at the other place of the work are in accordance with the specifications, the contractors shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programme shall be outlined by the contractor and finally accepted by the owner/authorize representative after discussion before the award of contract. The QA programme shall be in line with ISO 9001/IS-14001.

2.10 GENERAL REQUIREMENTS QUALITY ASSURANCE

All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all stages, as per comprehensive quality assurance programme. An indicated programme of the inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specifications. This is however, not intended to form a comprehensive programme as it is the contractor responsibility to draw up and implement such programme duly approved by the owner. The detailed quality plans for manufacturing and field activities should be drawn by the bidder and will be submitted to owner for approval. Schedule of finalization of such quality plans will be finalized before award. Manufacturing quality plan will detail out for all the components and equipments, various tests/inspection, to be carried out as per the requirement of this specification and standards mentioned therein and quality practices and procedure followed by contractors quality control organization, the relevant reference documents and standards, acceptance norms, inspection documents raised etc during all stages of material procurement, manufacturer, assembly and final testing performance testing. Field quality plans will detail out for all the equipment the quality practices and procedures etc, to be followed by the contractors site quality control organization, during various stages of site activities from receipt of materials/equipment at site. The contractor shall also furnish copies of reference documents/plant standards/acceptance norms/tests and inspection procedure etc, as referred in quality plans along with quality plans. These quality plans and reference documents/standards etc will be subject to Owner's approval without which manufacture shall not proceed. These approved documents shall form a part of the contract. In these approved quality plans Owner shall identify Customer Hold Points (CHP), i.e., test/checks which shall be carried out in presence of the Owner's engineer or his authorized representative and beyond which the work will not proceed without consent of Owner/authorized representative in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner along with technical justification for approval and dispositioning. No materials shall be dispatched from the manufacture's work before the same is accepted subsequent to pre-dispatch final inspection including verification of records of all previous tests, inspection by Owner's engineer/authorized representative, and duly authorized for dispatch insurance of MDCC. All materials used for equipment manufacture including casting and forging etc shall be tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedure recommended

and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and or agreed details.

ANNEXURE-C

TECHNICAL SPECIFICATIONS OF LINE INTERFACE UNIT, STRAIGHT JOINT CLOSURE OF OFC CABLE AND PLB PIPE.

(i) LINE INTERFACE UNIT:

The LIU should be wall mountable multi-purpose mechanical box offering the function of splicing fibre to pigtails and connector patching.
The LIU should provide mechanical and environmental protection for both fibre and its components and permit higher standards of fibre management. This is typically located in the customer premises.

Features:

- It should be designed for the fibre to pigtail splicing & patching between the pigtails & patch cord.
- It should be provided with minimum of two cable entries.
- Cable & pigtail glands are included in the kit. Preinstalled splicing trays, fibre protection tube and patch panel for 24 Fibre.
- Splicing concept ensures bend radius protection and solutions for all types of fibres.
- Compact and modular wall mounted customer termination box for 24 connectors.
- The metal chassis is to be made of CRCA material.
- Powder coating thickness should be 60-90 microns.
- Pigtail to be terminated to 24 No. SC connecters and assembled in LIU

(ii) STRAIGHT JOINT CLOSURE OF OFC CABLE:

Cable straight joints are to be of BSNL approved vendor and suitable for 12F UG OFC.

(iii) PLB HDPE Pipe and Accessories

The following paragraphs describe the functional requirements, major technical requirements for Permanently Lubricant High Density Polyethylene (PLB HDPE) Pipe. PLB HDPE pipe shall be suitable for underground fibre optic cable installation by blowing as well as conventional pulling. The PLB HDPE pipe shall be suitable for laying in trenches by directly burying, laying through G.I/RCC hume pipe and laying through trench less digging.
The unit rates quoted in the price schedule shall be the composite price of PLB HDPE pipe along with all accessories.

Construction of PLB HDPE pipe

The PLB HDPE pipe shall have two concentric layers viz. outer layer and inner layer. The outer layer shall be made of HDPE material and the inner layer of solid permanent lubricant. These concentric layers shall be co-extruded and distinctively visible in cross-section under normal lighting conditions and generally conform to IS-9938.

Material

The raw material used for the PLB HDPE pipe shall meet the following requirements:

(i) The anti-oxidant establishers, color master batch and other additive used shall be physiologically harmless and shall be used only to minimum extent necessary to meet the specification.

(ii) Usage of any additives used separately or together, should not impair the long-term physical and chemical properties of the PLB HDPE pipe.

(iii) The base HDPE resin used for manufacturing outer layer of pipe shall conform to any grade of IS-7328 or to any equivalent standard meeting the following requirement when tested as per standards referred in this Section below.

a) Density (outer and inner layer): 940 to 958kg/m3 at 27°C. The density of completed PLB HDPE shall not be differ by more than 0.003gms/cc by this value when tested as per IS: 2530 or IS: 7328.

b) Melt Flow Rate (MFR): 0.2 to 1.1 g/10 minutes at 190° & 5kg load: when tested as per IS: 2530.The MFR of the outer layer of the completed PLB HDPE pipe shall not differ by more than 30% of this value.

c) Tensile Strength at Yield:20 N/mm2 minimum, when tested As per ASTM D638, Type-IV specimens

(iv) In the inner layer of PLB HDPE pipe, the friction reducing, polymeric material to be used as the inner layer lubrication material shall be integral with HDPE layer. The lubricant materials shall have no toxic or dermatic hazards for safe handling.

Dimension of pipe

The nominal size of the pipe shall be 40mm and shall meet the following requirements.

(i)	Outside diameter	40mm+0.4 mm
(ii)	Wall thickness	3.5mm
(iii)	Standard length	1000 meters ±100 meter
(iv)	Thickness of permanent lubricant,	≥ 0.4 mm

Accessories of PLB HDPE pipe

The following accessories are required for jointing the pipe and shall be supplied along with the pipe. The manufacturers shall provide complete design details, procedure for method of installation and type of the material used for the accessories. No part of the accessories shall contain metal part and minimum pulling force of the coupler shall be 330kgf. The accessories shall pass the ageing test at 70+2° C and there shall be no leakage when tested for 168 hours.

Plastic coupler:

The coupler shall be used to join two PLB HDPE pipes. The coupling shall be able to provide a durable airtight and watertight joint between two pipes without deteriorating the strength of the pipes. The strength of coupler shall match the primary strength of the PLB HDPE pipe and threaded coupler is not acceptable. The jointing shall meet the air pressure test of 15 kg/cm2 for a minimum period of 2 hours without any leakage.

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